MACHINERY.

October, 1906.

MACHINE TOOL DRIVES.

JOHN EDGAR.

ONE of the first problems encountered in the design of a new machine tool is that of laying out the drive. The importance of a properly proportioned drive is coming more and more to be recognized. The use of high-speed steels and the extra high pressure under which modern manufacturing is carried on precludes the use of any but the most modern and efficient drive.

The drive selected may be one of the following different kinds, depending on the conditions surrounding the case in hand: We may make the drive to consist of cone pulleys only; we may use cone pulleys in conjunction with one or more sets of gears; or we may make our drive to consist of gears only, depending on one pulley, which runs at a constant speed, for our power. If the conditions will allow, we may use an electric motor, either independently or in connection with suitable gearing.

After having selected the form which our drive is to take and the amount of power to be delivered, which we will

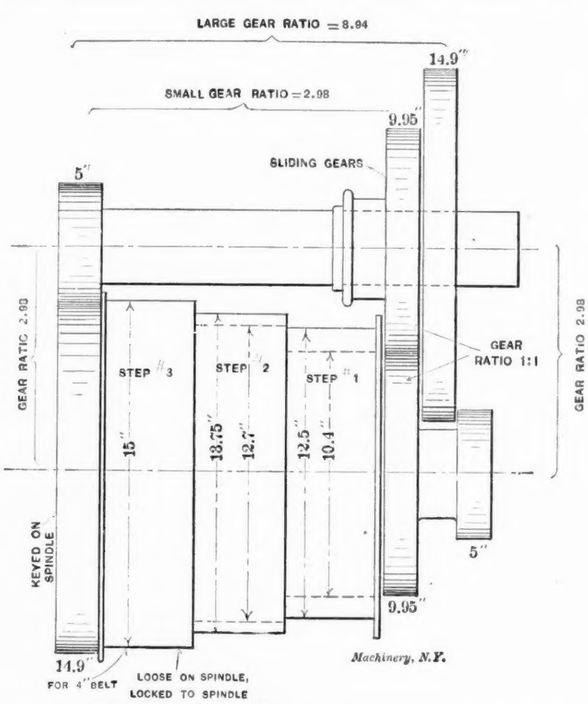

Fig. 1. Two Methods of Laying Out the Cone for a Double Back-geared Spindle.

assume has been decided upon, we may turn our energies to the problem of arranging the successive speeds at which our machine is to be driven. As most machines requiring the kind of drive with which this article is concerned have spindles which either revolve the work or a cutting tool that has to be worked at certain predetermined speeds dependent on the peripheral speed of the work or cutter, a natural question to be asked at this point is, "What is the law governing the progression of these speeds?"

As an example to show what relation these speeds must bear to one another, let us suppose that we have five pieces of work to turn in a lathe, their diameters being 1, 2, 5, 10 and 20 inches respectively. In order that the surface speed may be the same in each case we must revolve the one-inch piece twice as fast as the two-inch piece because the circumference varies directly as the diameter, so that a two-inch piece would be twice as great in circumference as the one-inch piece. The five-inch piece would revolve only one-fifth as fast as the one-inch piece; the 10-inch piece 1/10th, the 20-inch piece 1/20th. We have seen that the addition of one inch to the diameter of the one-inch piece reduces the speed 100 per cent. If we add one inch to the two-inch piece we reduce the speed 50 per cent, and similarly one inch added to the 5-, 10-, and 20-inch pieces reduces the speed 20, 10 and 5 per cent respectively. From this we see that the speed must vary inversely with the diameter for any given surface speed. It also shows that the speeds differ by small increments at the slow speeds, the increment gradually increasing as the speed increases. Speeds laid out in accordance with the rules of geometrical progression fulfill the requirements of the above conditions.

If we multiply a number by a multiplier, then multiply the product by the same multiplier, and continue the operation a definite number of times, we have in the products obtained a series of numbers which are said to be in geometrical progression. Thus 1, 2, 4, 8, 16, 32, 64 are in geometrical progression, since each number is equal to the one preceding, multiplied by 2, which is called the ratio.

The above may be expressed algebraically by the following formula:

$$b = a\,r^{n-1}$$

where b is a term or number which is the nth term from a which is the first term in the series. The term r is the ratio or constant multiplier.

If we are given the maximum and minimum of a range of speeds we may find the ratio by the following formula, when the number of speeds is given:

$$r = \sqrt[n-1]{\frac{b}{a}}$$

As most cases in which we would use this formula would require the use of logarithms, we will express the above as

$$\text{Log } r = \frac{\text{Log } b - \text{Log } a}{n - 1}$$

Let us suppose we are designing a drive which is to give a range of 18 spindle speeds, from 10 to 223 revolutions per minute. Now the first thing to be done is to find the ratio r, which, by the above formula gives as a result 1.20 and by continued multiplication the series is found to be 10, 12, 14.4, 17.25, 20.7, 24.85, 29.8, 35.8, 43, 51.6, 62, 74.4, 89.4, 107, 129, 155, 186, 223.

Our drive can be made to consist of one of the many forms above mentioned. As the cone and back gears is the most common and fills the conditions very well, we will choose that style drive for the case in hand.

We may have a cone of six steps, double backgears and one counter shaft speed, such as would be used in lathe designs, or we may use a cone with three steps, double back gears and two counter shaft speeds as is used in milling machines. This latter plan will be followed in our present case.

There are two methods of arranging the counter shaft speeds. First, by shifting the machine belt over the entire range of the cone before changing the counter shaft speed; and second, by changing the counter shaft speed after each shift of the machine belt. The method used will have a very important effect on the design of the cone. The cone resulting from the former practice will be quite "flat," with very small difference in the diameter of the steps, while the use of the second method will produce a cone which will have a steep incline of diameters. Some favor one, some the other. The controlling point in favor of the first method is the appearance of the cone obtained.

We will first design our drive with the conditions of the first method in view; that is, we will arrange our counter shaft speeds so that the full range of the cone is covered

before changing the counter shaft speed, thus obtaining the flat cone.

Tabulating the speeds in respect to the way they are obtained, we have

CONE.	Open Belt.		Small Ratio Back Gears in.		Large Ratio Back Gears in.	
	Fast Counter.	Slow Counter.	Fast Counter.	Slow Counter.	Fast Counter.	Slow Counter.
Step 1.....	223	129.	74.4	43.	24.85	14.4
Step 2.....	186	107.	62	35.8	20.7	12.
Step 3.....	155	89.4	51.6	29.8	17.25	10.
	1	2	3	4	5	6

From the above table we may obtain the ratio of the two sets of back gears, the counter shaft speeds, and the speeds off of each step of the cone.

The ratio of the large ratio back gears is found by dividing one term in column 2 by a corresponding term in column 6. The ratio of the small ratio gears is found by dividing a term in column 2 by a corresponding term in column 4. The ratio of counter shaft speeds is obtained by dividing a term in column 5 by a corresponding term in column 6; and the ratio of the speeds off each step of the cone, by dividing the term corresponding to step 1 in any column by a term corresponding to step 2 or 3, as desired, from the same column. The results for the present case are as follows:

Ratio of large ratio gears is.............. 8.94 to 1
Ratio of small ratio gears is.............. 2.98 to 1
Ratio of counter shaft speeds is.......... 1.725 to 1
Ratio of speeds off step 1 to those off step 2. 1.2 to 1
Ratio of speeds off step 1 to those off step 3. 1.44 to 1

The matter of designing the cone seems to cause trouble for a good many if we are to judge by the results obtained, which are various in any collection of machine tools, even in those of modern design. It is possible to design a cone so as to obtain speeds in strict accordance with the geometrical series.

In most cases the countershaft cone and the one on the machine are made from the same pattern so that it is necessary that the diameters be the same for both cones, and since the belt is shifted from one step to another the length must be kept constant. This is accomplished by having the sum of diameters of corresponding steps equal.

We will take as the large diameter of the cone, 15 inches. The ratio of the speeds off step 1 and step 3 is 1.44 to 1. This ratio also equals $\frac{D \times D}{d \times d}$ where D is the diameter of largest step and d is the diameter of smallest step. Making them opposite terms in an equation we get,

$$1.44 = \frac{D \times D}{d \times d} = \frac{D^2}{d^2}$$

$$\text{or } 1.44 \times d^2 = D^2$$

$$d = \sqrt{\frac{D^2}{1.44}} = \sqrt{\frac{15 \times 15}{1.44}} = 12.5 \text{ inches, dia. of small step.}$$

The sum of the corresponding diameters on the cones is $15 + 12.5 = 27.5$.

Since this is a three-step cone the middle steps must be equal. Therefore $\frac{27.5}{2} = 13.75 =$ diameter of middle step. We found that the ratio of the speeds off first and second step is 1.2. Let us examine the above figures to see that the diameter of the middle step is correct. Thus,

$$\frac{15}{12.5} \times \frac{13.75}{13.75} = 1.2,$$

which is the correct ratio. This cone is shown in Fig. 1.

Let us now figure the diameter of the back gears. We will assume that the smallest diameter possible for the small gears in the set is 5 inches. In order to keep the gears down as small as possible we will take this figure as the diameter of the small gear here. It is general practice, though obviously not compulsory, to make the two trains in a set of back gears equal as to ratio and diameters. When double back gears are used, the large ratio set is made with two trains of similar ratio. The small ratio set is then composed of two trains of gears whose ratios are unlike. The ratio of each train in the large ratio set, if taken as similar, is equal to the square root of the whole ratio; thus, in our drive we have $\sqrt{8.94} = 2.98$, and from this the large gear is $5 \times 2.98 = 14.9$ inches in diameter. The ratio of the small ratio set is equal to 2.98 and as one train of gears in the double back gear arrangement is common to both sets, the remaining train in the small ratio set must be of equal diameters, or $5 + 14.9 \div 2 = 9.95$ inches, as shown in Fig. 1. These figures will have to be slightly altered in order to adapt them to a standard pitch for the teeth, which part of the subject we will not enter here.

In order to be able to compare the results of the two different methods of counter shaft speeds mentioned above, let us figure out the dimensions of a drive with counter shaft speeds arranged according to the second method.

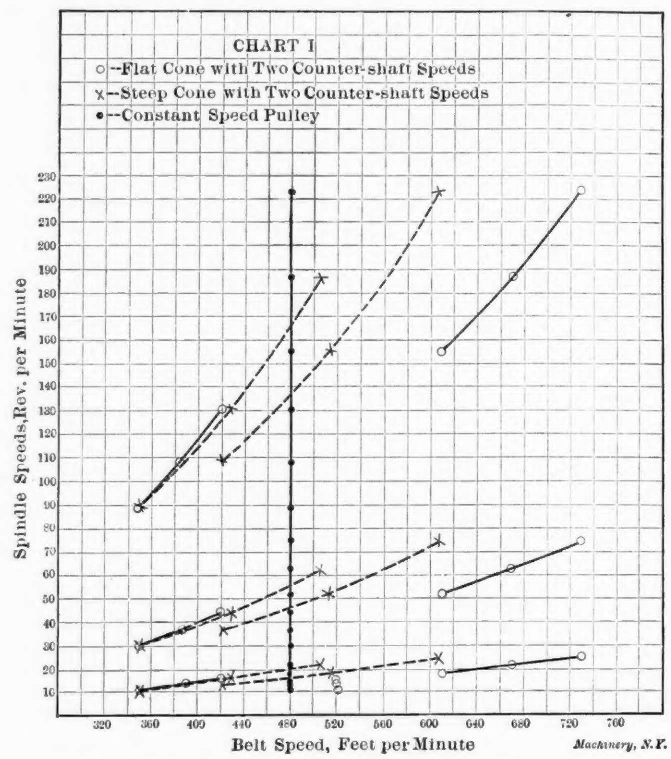

Fig. 2. Variation in Belt Speeds for Various Methods of Driving.

Proceeding in a manner similar to that pursued for the case treated above, we tabulate the speeds as follows:

CONE.	Open Belt.		Small Ratio Gears in.		Large Ratio Gears in.	
	Fast Counter Speed.	Slow Counter Speed.	Fast Counter Speed.	Slow Counter Speed.	Fast Counter Speed.	Slow Counter Speed.
Step 1.....	223	186.	74.4	62.	24.85	20.7
Step 2.....	155	129.	51 6	43.	17.25	14.4
Step 3. ...	107	89.4	35.8	29.8	12.	10.
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The various ratics are:
Large ratio gears is 8.94 to 1.
Small ratio gears is 2.98 to 1.
Counter shaft speeds 1.2 to 1.
Speeds off step 1 to those off step 2, 1.44 to 1.
Speeds off step 1 to those off step 3, 2.07 to 1.

The cone dimensions are figured in the same manner as the former and are 10.4 inches for step 1; 12.7 for step 2; 15 for step 3. This cone is shown dotted in Fig. 1.

We are now in a position to compare the results given by the two methods above referred to. Let us make the first comparison from the point of view of power delivered by the belt. It is well-known that the power of a belt is directly proportional to the speed at which it runs. This fact gives

us an easy means of comparing our two designs. We will do this by charting the speed in feet per minute of the belt when running on the different steps of the two cones for each spindle speed. This has been done in Fig. 2, where the full lines show the curve for the first method and the dotted lines show that for the second method. The curves at the left are those for the slow counter speeds, while at the right are seen those for the fast counter speeds. Attention is called to the great difference in power delivered between the two counter speeds in the first case, while the two sets of curves for the second method lie close together. Also, note the gain in power at speeds obtained through the slow counter in the second case. The power lost in the second case on the fast counter speeds will not be felt so much, for the same principle applies here as it does to the strength of beams, bridges, etc., viz., a chain is no stronger than its weakest link.

The constant-speed pulley drive has become quite a common feature in machine tool design, and has become quite a strong favorite with many. Had our machine been provided with a drive of this design, we would have had a curve on the chart as shown by the vertical full line. The power delivered by the belt would have been constant throughout the full range of speed. This curve also applies to the motor drive, when a constant-speed motor or a variable-speed motor of the field control type is used, although slight modifications would have to be made for the decrease in efficiency at

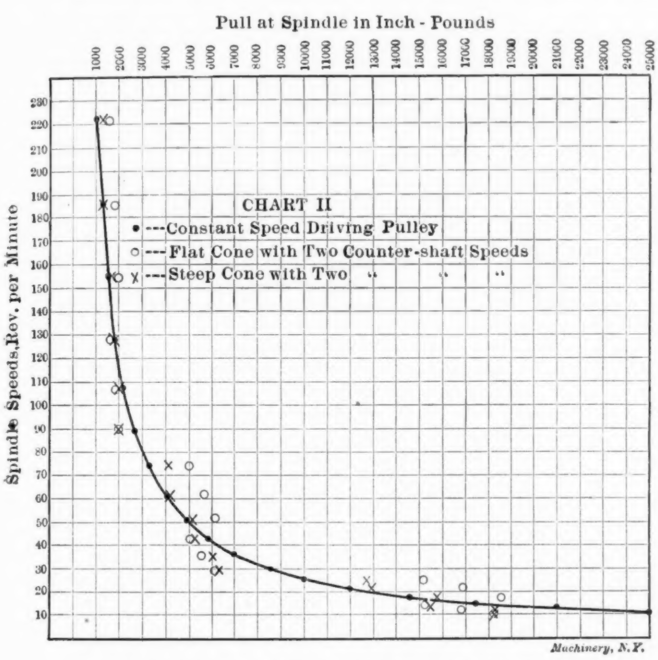

Fig. 3. Comparisons of Torque for Various Methods of Driving.

the extremes of the speed range of the latter type motor, which would cause a slight bend in the curve, making it convex toward the right. Motors using the multiple-voltage system or the obsolete armature resistance control would show curves quite as irregular as those from the cone and back gear drive.

Another method of comparison is by charting the pull or torque at the spindle for each spindle speed. This is done in Fig. 3, where the constant speed pulley drive is shown by the full line, and is used as a comparator by which to compare the results of the two drives treated above. This figure is self-explanatory and will not need to be interpreted, but attention may be called to how much better the drive of the second case follows the ideal line than does that of the first method. This chart also shows how very close a cone and double back gear drive comes to the constant belt-speed drive with equal power at all speeds.

Much has been said about the relative values of the two styles of cone pulleys treated above, but the charts given herewith will no doubt surprise some and may be the means of turning them in favor of the second method. The only good point the first method has over the second is in the appearance of the cone which has apparently powerful lines which are misleading as has been shown.

Another disadvantage of the first method is the wide ratio of the countershaft speeds, where, in order to get sufficient power out of the slow speed countershaft belt, we must have the high speed pulley running at almost prohibitive speed, which soon tells, and as loose pulleys are a source of annoyance when their speed is moderate, trouble is sure to make its appearance when the limit of speed is approached.

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IMPULSE AND REACTION TURBINES DEFINED.

In the second edition of their bulletin "Steam Turbines and Generators," issued by the Allis Chalmers Co., the difference between impulse and reaction turbines is defined, and the reason for the adoption of the reaction type by the company is given substantially as follows:

"Briefly stated, steam turbines can be divided into two general types, *i. e.*, impulse and reaction. In the impulse type steam, before doing any useful work, is expanded in nozzles, its pressure being considerably reduced, while it acquires a high velocity before acting upon the revolving buckets or blades. In some turbines there is only one row or ring of revolving buckets and the turbine runs at a very high speed proportionate to the velocity of the steam jet, thus necessitating the employment of gearing to reduce the speed to workable limits. In other turbines two or more rows of buckets are used, each of which absorbs a part of the steam velocity, thereby reducing the peripheral speed. For the purpose of obtaining better economy in the newer impulse turbines, the steam is passed through several successive sets of nozzles and their subsequent rows of buckets. In the reaction type of steam turbine the steam acts directly upon the blades without initial reduction in pressure except such as may be effected by the governer in securing speed regulation. The steam flows through a large number of rows of blades alternately stationary and revolving. Guided by the stationary blades against the revolving blades the steam expands continuously throughout the length of the turbine, alternately gaining velocity and imparting it to the rows of blades partly by impulse but to great extent by the reaction as it issues from the revolving blades. There is no great change in pressure at any point, the reduction seldom exceeding three pounds at any one row of blades.

"In deciding upon the reaction type of turbine the company was influenced not only by the large number of that type in successful operation and its superior economic results in actual practice, but also by the fact that the reaction turbine will maintain its original steam economy after long service, principally on account of the low steam velocities. When it is considered that in commercially successful reaction turbines the steam velocity is less than one-fourth of that in impulse turbines, and that the erosive effect of steam advances as the square of the velocity, this conclusion would seem reasonable."

* * *

When reviewing the utterances in the German technical press relative to the trade relations with the United States, it is impossible to be blind to the fact that there exists a decided discontent with the present conditions on the part of German machine manufacturers. While American machinery is admitted to Germany subject to a tariff so low as to be almost insignificant, the American tariff on machinery is so high as to make import almost prohibitive. That these extreme differences cannot in the long run be calculated to increase the trade relations between the two countries is evident, and American machine builders may probably have to expect that the German manufacturers will bring such pressure upon their government as to materially increase the present tariff duties on machinery. There is, of course, another solution to the problem, a material reduction of tariff duties in this country, but whether American manufacturers will be willing to offer this solution is doubtful.

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The extended use of the automobile is so clearly in evidence that reference to the fact is hardly necessary. It is of interest, however, to note that the Massachusetts Highway Commission has licensed over 16,000 automobiles in all, and more than 5,000 during the past months of the present year.

SOME FEATURES OF WORKS MANAGEMENT AND EQUIPMENT.

THOMAS B. O'NEILL.

The present engineering corps at the Philadelphia plant of the Link Belt Company numbers about eighty-five men and includes the chief engineer, assistant chief engineer, three chief draftsmen and eighty draftsmen. In addition, several tracers are regularly kept and a clerical force maintained, approximating a dozen hands. The work of the drafting room is divided into preliminary, or estimate drawing, in charge of one of the chief draftsmen, with a force of ten or twelve men, and "ordered" work, in which the remaining draftsmen, directed by the assistant chief engineer and two chief draftsmen, are employed. The preliminary drafting is done in response to inquiries that come through the contract department and is forwarded through that channel to its ultimate destination.

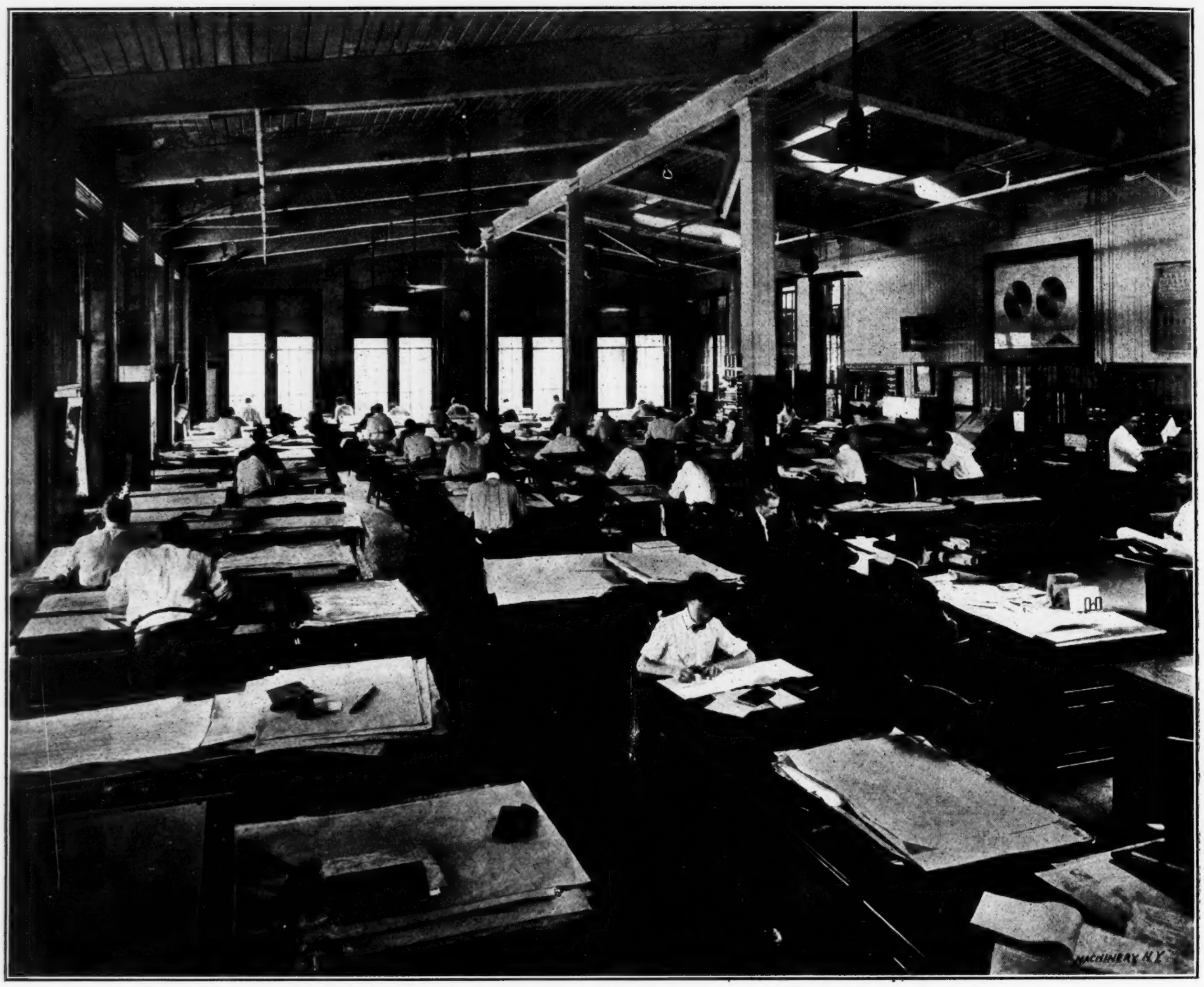

Fig. 1. Engineering Corps and Drafting Force, Philadelphia Plant, Link Belt Co.

With the acceptance of the schemes outlined and issuance of a formal order, regular drafting commences by having the salient features of the design passed upon by the chief engineer; his approval and instructions accompany the sketch to the directing head of the drafting room, who selects the man or men needed for completion of the drawings. When a job is large enough to warrant it, a draftsman is given a "squad" to attend to the detailing and tracing, he doing the actual engineering work and checking. He also superintends the listing of the material necessary and verifies the compilation. Typewritten lists are used and duplicates issued to the various shops and to the foremen in charge of erection.

As in all large departments of its kind, men who may be denominated specialists are among the regular force thus mentioned: those whose experience is along the lines of civil engineering, including the structural designers; those grounded in the practice of surveying, and others whose forte is building construction; while the mechanical force is divided into several classes of strictly link-belt engineering, and takes in the conveying, elevating and power-transmission men.

Photo and Blueprint Department.

In addition to making and issuing the blueprints necessary for its engineering force, the Philadelphia house maintains a fully equipped photographic department, which supplies the demands of the branch offices as well as the local needs. This is under the direction of a regularly employed photographer, whose duties also cover the preparation of the blue paper and the making and distribution of prints; in the latter work he is assisted by three boys, one of whom helps with the actual photographic work as occasion demands.

The completeness of the facilities provided is shown by the plan, Fig. 3. One end of the room which occupies the front part of the second floor, contains the dark room (entrance to which is gained through a serrated vestibule), enlarging and retouching apparatus, paper cutters and burnisher. The adjoining department is a regularly skylighted operating room and contains tanks, electric light printing apparatus and oscillating copying camera. Negatives to the number of nearly 3,500 are stored in a fireproof vault directly beneath. One of the practices is to keep on hand, ready for instant use, a complete stock of blueprints made from photo negatives, these prints being filed numerically in boxes within easy reach of the photographer and his assistant. Because of the great volume of blueprinting, the paper is prepared on the premises, a specially designed coating machine being used. On an average, about 2,000 yards of finished paper is turned out in a month.

To take care of the demands created, three electric blue-

printers of the vertical cylinder type are used to the total exclusion of daylight printing frames. There is hardly any reason to dwell upon the difference in results attained by the electric outfit, it being well known that daylight printing has been completely eclipsed. The time required to make a print is about two and one-half minutes; and the work of washing, drying (a wringer being used to quicken this), trimming and sending a standard 24 x 36-inch print to the drafting room

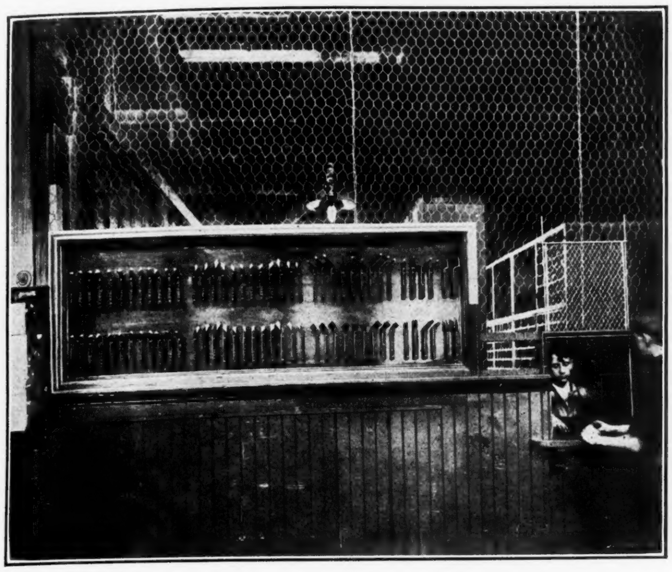

Fig. 2. Tool Room and Tool Rack showing Shapes.

occupies about the same length of time. This gives *five minutes* for a complete, ready-to-use print, and may be cited as a criterion of the calls made upon the department—17,000 prints being the number recorded in one month recently.

The Tool Room.

Tool-room routine is effected by the planning room; every tool needed by a machinist being designated by its symbol on the instruction card which is given a workman to govern the particular job on hand. This card indicates the nature of the work, kind of tool to use, the length of time required needed, these checks are presented to the tool-room attendant, who gives the tool called for, and upon its return refunds the check which has been put in the place made vacant by the withdrawal of the tool. Each tool has its own symbol, which in turn, is part of a general or classification symbol, governing a particular kind of tool. For instance, the sample board shown by Fig. 2 contains a collection of "paring tools," the symbol of which is "P," followed by letters and numbers designating the kind (round nose, square, etc.) and size. This initial classification is followed with regard to all of the tools used. Clamps are indicated by "C," drills by "D," and so on throughout the complete category.

The messenger service is controlled by the men; when a tool is needed the machinist signals by turning on an incandescent light placed at the entrance to the section in which he is at work, and visible from a signal board just outside the tool-room. This board is also fitted with incandescent lamps, numbered to indicate the different sections of the shop, and each lights simultaneously with the one switched on by the machinist. The messenger is thus quietly notified that he is needed, and goes to the part of the shop showing the signal, receives the check and symbol, secures the tool from the attendant and delivers it to the man needing it. The same method is followed for the return of the tool, which is inspected, ground or otherwise repaired, before being again available for use.

The interior of the tool room is arranged to give the utmost facility to the work of distribution. Nominally, each tool has its own particular receptacle, those of a class being allotted to the same section, and in the case of very small tools which, are alike, several are deposited in one box or bin. These boxes are portable and interchangeable, so that when it becomes necessary to discard a tool or set of tools, or to rearrange any part of the room, transfer from one rack to another can be made without recourse to enlarging or decreasing the shelving spaces. In other words, the unit system is here employed.

For very large and unwieldy tools, a special cabinet is used in which a set of turnstile doors hold a greater number than could otherwise be accommodated. There are also special contrivances, or kinks, employed to enable the attendant to secure quickly and easily those tools that, by reason of shape

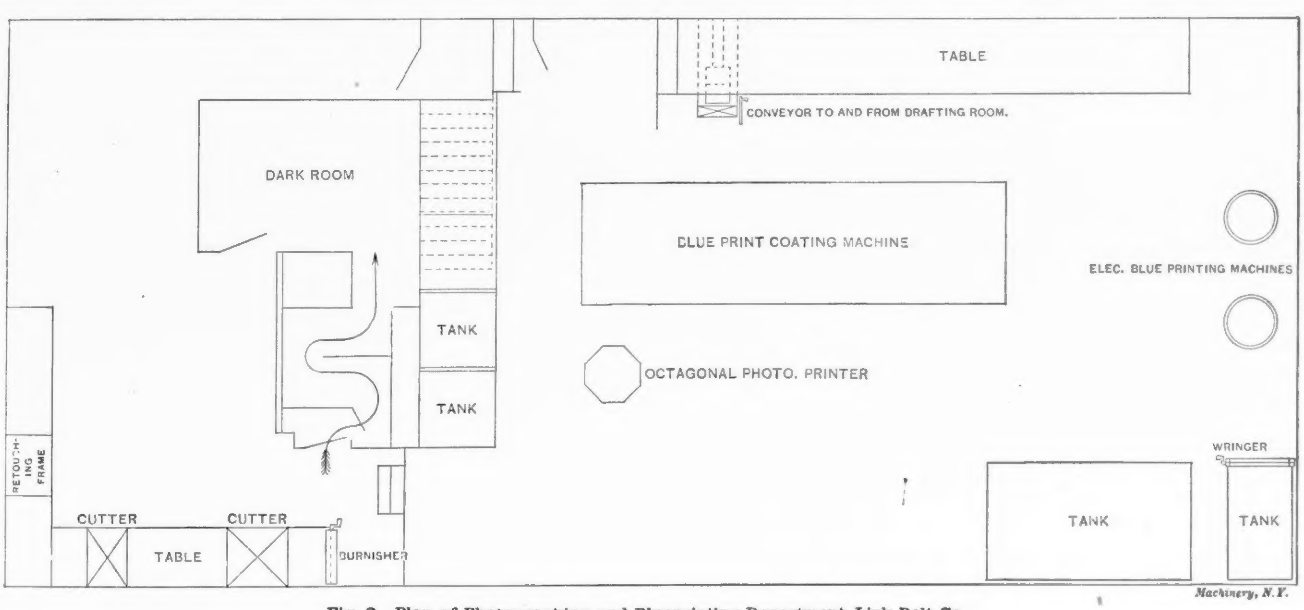

Fig. 3. Plan of Photographing and Blueprinting Department, Link Belt Co.

for the job, etc., and with the messenger service employed, relieves the foreman from extraneous duty and obviates the unnecessary journeying from bench to tool-room window and back that usually annoys and distracts a man, and more or less delays completion of work assigned to him. The advantages resulting from the method can be better explained by a synopsis of its operation from the time a machinist enters the employ of the firm.

When entered on the pay roll he is given several brass checks numbered to correspond with his pay roll entry. As or other cause, are more awkward to handle than the general run of appliances.

The resultant economy has been gratifying and scores strongly along with other elements of the "Taylor System."

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One of the most interesting of the recent experiments in England with long-distance omnibuses is a run from London to Glasgow, 400 miles, in twenty-nine hours. This is an average of about 14 miles an hour. Excepting for pleasure trips, however, it is doubtful if the long-distance omnibuses will prove a success.

THE COST OF GRINDING.

H. F. NOYES.

To figure, with any degree of accuracy, the cost of commercial wet grinding, requires considerable experience in the use and management of the machine in order to be as closely approximated as lathe work. There also seems to be a greater difference in operators, due partly no doubt to the fact that the general use of the grinder has not yet become as common. A great many operators seem to be afraid to push their machines, and spend a good deal of useless time in calipering. They seem to forget that if they have several thousandths to take off a piece and are feeding in one or two thousandths at each reversal of the machine, they need not caliper until within one or two thousandths of size, if they will keep in mind the number of reversals the machine has made. And another class seem to think that because grinding is a finishing job, it must be nursed.

As a matter of fact there is no machine which so readily and accurately responds to the touches of an operator as the wet grinding machine. Of course there are delicate pieces and certain shapes which have to be carefully handled, but the usual run of work is so simple that any good apprentice can be put on it and taught in a short time.

As the work usually comes from the lathe, with approximately 1/64 to 1/32 inch stock to be removed, a few reversals of the machine with the work taking nearly the full width of the wheel each revolution and a cut of two to four thousandths until nearly up to size and then a much slower traverse per revolution for finishing, according to the kind of finish desired, and the work is done. To obtain the best speed the limits required on the lathe must not be made too narrow, from 1/64 to 1/32 inch, being admissible for ordinary work, and more on large work; for the facility of the grinder in finishing work is far in excess of the lathe, and the latter must be relieved of all the finishing possible.

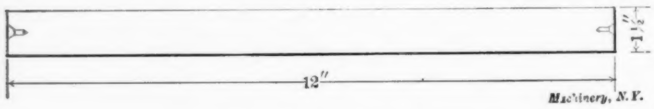


Fig. 1.

To figure the actual time for removing stock on the grinder we must take into account the longitudinal traverse of the wheel for each revolution of the work, the surface speed of the work and the depth of the cut. The latter must be varied according to the nature of the material, greater or less according to whether it is hard or soft; and the traverse per revolution of work is lessened if a fine finish is desired. The shape of the piece also somewhat affects both of these points as long, thin pieces require a slower traverse and lighter cuts.

Take, for instance, the plain piece, Fig. 1; material, hardened steel. For this a work surface speed of 15 feet, or about 37 revolutions per minute would be suitable. Assuming we have a wheel 18 inches in diameter, and 1½ inch face, a traverse of two-thirds the face of the wheel or one inch per revolution of work is usual. This would require 12 revolutions to pass the length of the piece, plus 1 revolution for clearance, or for dwell if there happens to be a shoulder. This would make, roughly, three reversals a minute.

On a medium-sized machine an automatic feed equivalent to a work reduction of about 0.002 inch would be suitable, or a reduction of about 0.006 inch per minute. If the work came with an average allowance of 0.030 inch for grinding it would require theoretically 5 minutes to rough this piece down actual grinding time. To this must be added the time for handling the work, adjusting the machine and back rests (in this case only one rest would be used), calipering the work and finishing. This time will amount to as much as the grinding time with most operators (most of it being taken up in finishing), which would make the actual time about ten minutes apiece. As a matter of fact, work of this size is being ground in the shop where I am employed at the rate of seven or eight pieces per hour.

If a fine finish is desired a higher work speed and slower traverse would be desired. For a very fine finish a work speed of 45 feet surface speed and traverse of 1/6 inch per revolution would be suitable for finishing, with, of course, a very much smaller feed. This change in the work and traverse speed could be made when the work is nearly up to size, and would probably require about three minutes. If the piece were of soft steel a deeper cut can be taken and a wider traverse, a cut of 0.003 inch and a traverse nearly up to the width of the wheel being admissible. In grinding long shafts it is necessary to allow proportionately more time for adjusting back rests and for calipering, to insure that the piece be straight. This often takes twice the actual grinding time.

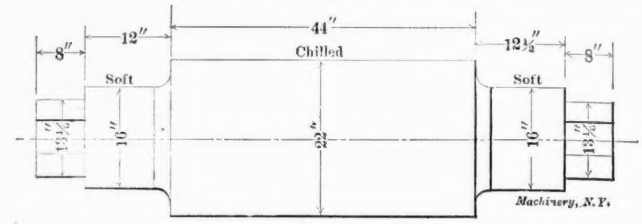


Fig. 3.

Now let us look at the more complicated piece, Fig. 2. This will have to be done on a larger machine, and the larger machines are slower to handle. This piece is a piston rod of 40 carbon steel. We will use for this a 20-inch wheel of 2½ inches face. A suitable traverse for this would be 2 inches per revolution and a surface speed of 15 feet would make about 19 revolutions for the part 3 inches in diameter, and about 15 for the part 3¾ inches. The figures would be about as follows:

Total amount to be removed, 0.060 inch; amount per reversal, 0.004 inch; number of reversals required, 15.

3 inches diameter, to cross once, 1 1/5 minute; total for 15 reversals	18 minutes
3¾ inches diameter, to cross once, 1½ minute; total for 15 reversals	22 minutes
Tapers both, to cross once, 2/5 minute; total for 15 reversals	6 minutes
Setting up and adjusting	10 minutes
Total	56 minutes

If it be desired to put a radius on the wheel and grind the fillets at shoulder *A*, about 10 minutes more should be allowed; and if there were more than one piece to be done considerable time could be saved in setting for the tapers.

The piece, Fig. 3, is a chilled cast-iron roll to be ground from the rough. This will take the largest machine built, and here the time taken is almost all grinding time. The average reduction for the chilled part is ¼ inch, and a feed of 0.002 inch is about all we can take, with a 30-inch wheel, 3-inch face and about 2-inch traverse per revolution. A work speed of 15 feet would give us about 3 revolutions per minute, making about 7 minutes for once across the roll and 14½ hours for the chilled portion of the roll.

For the soft necks of the roll (average reduction ½ inch) we can take a surface speed of 20 feet, equivalent to about 5 revolutions per minute, a feed of 0.004 inch and a traverse of about 2½ inches, which would make a total grinding time of slightly over 20 hours for the whole piece, or, including setting and adjustments, of about 21½ hours.

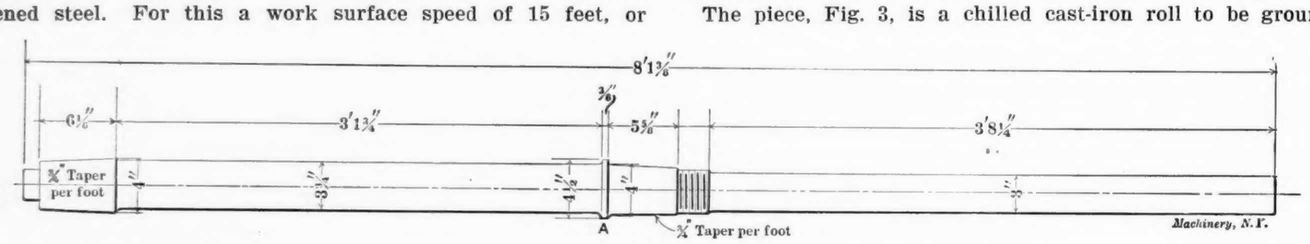


Fig. 2.

BRAKES.—3.

AUTOMATIC BRAKES.

C. F. BLAKE.

Fig. 8 represents what is known as the Weston brake, which is the typical form of a very large class of automatic brakes used on hand and electric cranes to control the load.

A pinion A mounted loose on the shaft has formed on one hub a spiral surface normal to the shaft, and on the opposite end a faced surface to present to the friction disks e. A collar, D, fast on the shaft, has a spiral surface to engage that of the pinion hub, and is backed up by a split washer or other device to resist end-pressure along the shaft. A flange B loose on the shaft has a faced surface similar to that on pinion A, and carries a ratchet to engage a pawl C. A series of friction disks e are placed between the faced surfaces on A and B in such a manner that the disks in contact with A and B shall be keyed by sliding feathers to B and A respectively.

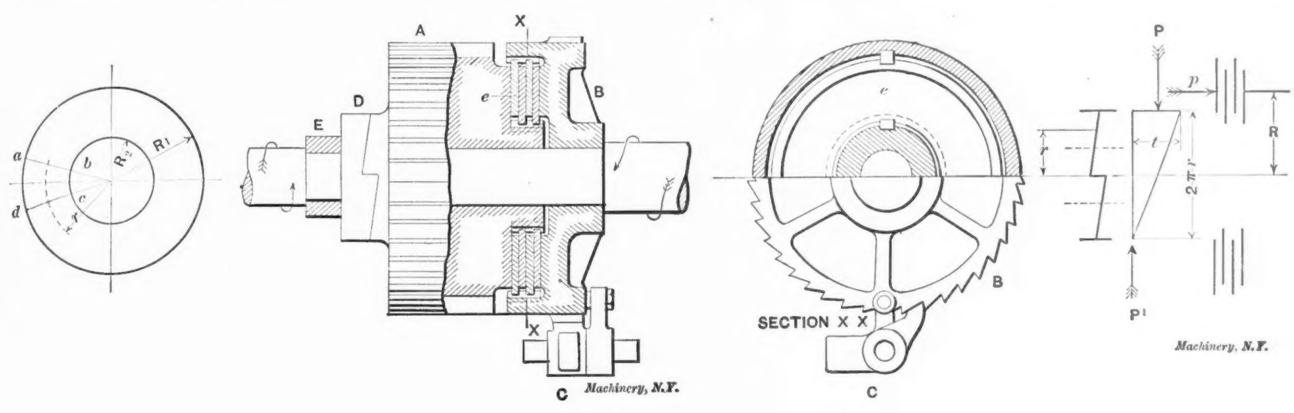


Fig. 8. The Weston Brake, and Diagrams referring to the Calculations.

It will be seen that this gives each disk a motion opposite to that of its neighboring surfaces, and each two surfaces in contact having opposite directions of rotation form one friction surface of the brake. Thus the brake shown in Fig. 8 has five friction surfaces and four washers or disks. These disks are made of various materials, alternate disks of steel and brass, or steel and fiber are frequently used, as also is polished saw steel for all the disks.

The shaft revolves in the direction of the arrow on the right to hoist, and with the arrow on the left to lower; the ratchet teeth are formed to permit the rotation of the flange B when hoisting, and prevent it when lowering; the pawl C is counterweighted to throw it into engagement with the ratchet; flange B is backed against a shoulder on the shaft, so that all the end-thrust is taken by the shaft between this shoulder and the split collar E, and the brake is spoken of as being self-contained. The action of this brake is as follows:

Suppose a load on the pinion A tending to revolve it in the direction of the left-hand arrow, and suppose the shaft to begin to turn in the direction of the right-hand arrow. D being fast on the shaft will revolve opposite to A, which will cause the spirals to slip and thrust A toward B, thus clamping the disks e between A and B, the end-thrust of D and B being taken by the shoulders on the shaft. In this manner the whole mechanism consisting of D, A, e and B is locked solidly together, and is made fast upon the shaft and thus the pinion A is driven and the load raised.

To lower, the shaft is turned in the direction of the left-hand arrow, carrying D with it, and since A is clamped tight to B through the disks e, and B is prevented from rotating by the pawl C, D is given motion relative to A in the direction of releasing the spirals, and thus the thrust upon A. Immediately this thrust is relieved A turns freely in the direction of the left-hand arrow under the influence of the load, and overhauling the shaft with its collar D, brings the spirals again into contact, re-establishing the locked condition and holding the load suspended.

A further motion of the shaft results in a repetition of this cycle, and indeed the act of lowering the load consists of an infinite number of such repetitions in a unit of time, the motion of the load resulting from each cycle being infinitesimal, thus making the motion of the descending load uniform.

The spirals are in effect nothing more than a wedge used to put pressure on the disks e, and the action of the brake is shown in the diagrams at the right and left, in which

r = the mean radius of the spiral,

R = the mean radius of the friction disks.

The claim is made by some designers that instead of taking this mean radius, such a radius should be taken that

$$r = \frac{2}{3}\,\frac{R_1^3 - R_2^3}{R_1^2 - R_2^2}$$

thus taking the radius to the center of gravity of the small trapezoids, into which the circular disk may be supposed to be divided. Although this is true when the brake is new and the pressure is distributed uniformly over the entire surface, in use the outside of the disk wears faster than the inside, resulting in greater pressures at the inner edge, and it is found that the mean radius

$$r = \frac{R_1 + R_2}{2}$$

gives better results for working conditions.

Referring to the diagram at the right of Fig. 8, let

T = the torque on the shaft in inch-pounds,

n = the number of friction surfaces (actual planes of slipping), then

$\frac{T}{R}$ = the tangential force at the radius R required to drive, and

$\frac{T}{R\,n}$ = the tangential force at the radius R at one friction surface, required to drive.

Also if μ = the coefficient of friction between the disks,

$$p = \frac{T}{R\,n\,\mu}$$

The force required on the wedge is,

$P = \frac{p\,t}{2\,\pi\,r} = p \tan \alpha$, friction being neglected, and from Fig. 9,

$$P = p \tan \alpha \,[\tan(\alpha + \theta) + \tan \theta]$$

where $\tan \theta = \mu$, the coefficient of friction.

The force P to set the wedge arises from the load on the pinion teeth, and would be greatly in excess of that given by the formula were it not that the friction disks upon the first motion endwise of the pinion under the influence of the wedge, absorb the greater part of the torque of the tooth load, and a condition of equilibrium is brought about between the tooth load, the wedge and the disks. In other words, a certain portion of the pinion torque is used to set the wedge, and the rest is absorbed by the disks, and the ratio of these two portions is constant, which results in one of the characteristics of this type of brake, that the holding power is proportional to the load.

If the friction is just sufficient to prevent the wedge cone

from backing out and releasing the brake, then $P = O$, and $\alpha = 2\theta$. In order to leave a margin over such an unstable and dangerous condition we should always make $\alpha < 2\theta$.

The force P' required to back out the wedge cone, and, releasing the brake, to lower the load is,

$$P' = p \tan \alpha \, [\tan(\theta - \alpha) + \tan \theta]$$

Let R_1 = the length of the crank (if brake is in a hand crane),

F = the force applied to the crank to lower the load, then

$$F = \frac{P' r}{R_1 \, e}$$

if the crank and brake are on the same shaft, and the efficiency of the shaft bearings is e.

Where the two sides of the wedge cone are at different radii, as in Fig. 10, we have,

$$P = p \tan \alpha \, [\tan(\theta + \alpha)] \text{ at } b$$

and

$$P' = p \tan \alpha \, [\tan \theta] \text{ at } c$$

But P acts at a radius r while P' acts at a radius r_1, therefore the total torque required to set the wedge cone is,

$$T = P\,r + P'\,r_1 = r\,p \tan \alpha \, [\tan(\theta + \alpha)] + r_1\,p \tan \alpha \tan \theta$$

and the total force at the radius r required to set the wedge cone is

$$P_t = \frac{T}{r} = \frac{p \tan \alpha \, [r \tan(\theta + \alpha) + r \tan \theta]}{r}$$

Also

$$P' = p \tan \alpha \, [\tan(\theta - \alpha)] \text{ at } b$$

and

$$P'' = p \tan \alpha \, [\tan \theta] \text{ at } c$$

and the total force at radius r is by the same reasoning,

$$P_t' = \frac{T_1}{r} = \frac{p \tan \alpha \, [r \tan(\theta - a) + r_1 \tan \theta]}{r}$$

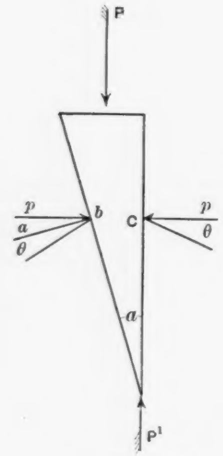


Fig. 9.

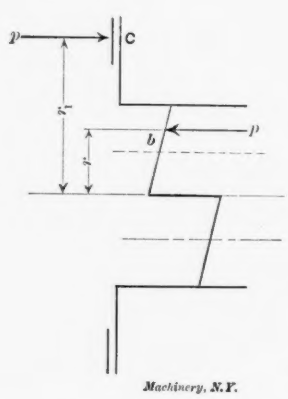


Fig. 10.

The ratio of the force required to set the brake in the two cases of Fig. 9 and Fig. 10 is

$$\frac{P_t}{P} = \frac{r \tan(\theta + \alpha) + r_1 \tan \theta}{r \tan(\theta + \alpha) + r \tan \theta}$$

Likewise the ratio of the force required to release the brake in the two cases is

$$\frac{P_t'}{P'} = \frac{r \tan(\theta - \alpha) + r_1 \tan \theta}{r \tan(\theta - \alpha) + r \tan \theta}$$

from which, since $r_1 > r$, we see it requires a greater force to set or release the brake under the conditions of Fig. 10, than under those of Fig. 8, and that for delicate control the friction surfaces on the power side of the brake should have as small mean radii as possible under the limiting conditions of pressures per unit area.

Kent gives for the coefficient of friction under the best obtainable conditions,

$$\mu = 0.03 \text{ to } 0.036,$$

and for smooth surfaces continuously oiled, $\mu = 0.05$, which latter fits the conditions of brakes running in oil baths, as do some of the modifications of the Weston brake used on cranes.

Examples on the Weston brake.

1.—Torque on brake shaft = 7,500 inch-pounds.
Radius of helix = 2.5 inches.
Radius of back of helix = 2.5 inches.
Radius of disks = 7 inches.
Four disks having five friction surfaces.
Coefficient of friction between disks = 0.05, and between helix surfaces = 0.09.

$$p = \frac{T}{R\,n\,\mu} = \frac{7{,}500}{7 \times 5 \times 0.05} = 4285 \text{ pounds}$$

$\tan \theta = 0.09 \quad \theta = 5$ degrees

$\alpha < 2 \times 5^\circ < 10^\circ$, assume $\alpha = 8$ degrees $\tan \alpha = 0.14$

$\alpha + \theta = 13^\circ$, $\tan(\alpha + \theta) = 0.23$

$\theta - \alpha = -3^\circ$, $\tan(\theta - \alpha) = -0.05$

$$\begin{aligned} P &= p \tan \alpha \, [\tan(\theta + \alpha) + \tan \theta] \\ &= 4285 + 0.14 \, [0.23 + 0.09] \\ &= 193 \text{ pounds} \end{aligned}$$

$$\begin{aligned} P' &= p \tan \alpha \, [\tan(\theta - \alpha) + \tan \theta] \\ &= 4285 \times .14 \, [-0.05 + 0.09] \\ &= 24 \text{ pounds} \end{aligned}$$

2. Suppose in the above example the back of the spiral cone is provided with a fiber washer, or for some other reason has a coefficient of friction of $\mu = 0.13$; we would then have two values of θ, that for the spiral being $\tan \theta = 0.09$, $\theta = 5^\circ$, and for the back of the spiral $\tan \theta_1 = 0.13$, $\theta_1 = 7.5^\circ$. Then α must be less than $\theta + \theta_1$, or less than 12.5°, and in order to compare results we will take $\alpha = 8^\circ$ as before, and $\tan \alpha = 0.14$.

$\tan(\theta + a) = \tan(5^\circ + 8^\circ) = 0.23$

$\tan(\theta - a) = \tan(5^\circ - 8^\circ) = -0.05$

Then

$$\begin{aligned} P &= 4285 \times 0.14 \, [0.23 + 0.13] \\ &= 214 \text{ pounds} \\ P' &= 4285 \times .14 \, [-0.05 + 0.13] \\ &= 48 \text{ pounds} \end{aligned}$$

To emphasize the danger of taking α too great let α be taken $> \theta + \theta^1$ in the above example, or $\alpha = 14^\circ$, then

$$P = 4285 \times 0.25 \, [0.34 + 0.13] = 503 \text{ pounds}$$
$$P' = 4285 \times 0.25 \, [-0.16 + 0.13] = -32 \text{ pounds}$$

the negative sign for P' indicating that a force of 32 pounds would be required constantly in the direction of application of the brake while the load is suspended to prevent the load running down.

3. Suppose the back of the wedge cone is increased to 4 inches radius, still keeping the coefficient of friction 0.13, and we have

$$P = \frac{4285 \times 0.14 \, [(0.25 \times 0.23) + (4 \times 0.13)]}{2.5} = 257 \text{ pounds}$$

$$P' = \frac{4285 \times 0.14 \, [(2.5 \times -0.5) + (4 \times 0.13)]}{2.5} = 94 \text{ pounds}$$

* * *

The steam engine has been, to a large extent, driven out of the central station field by the steam turbine. It naturally will hold its own for factory purposes where power is to be transmitted by belt and will also hold its own for many years to come for hoisting purposes, rolling mills, etc. But with the gradual introduction of electrically-driven machinery and shafting in all kinds of manufacturing plants; a greater use of motors for hoisting and for rolling mill driving, for which purposes they are now beginning to be adopted; and with a plentiful and cheap fuel like alcohol for small units, it begins to look as though we were to depend upon other motive powers than the steam engine in perhaps the majority of plants within a comparatively few years from the present time.

* * *

The Mechanical World mentions that in order to reduce the danger of collisions on single-track railways, the Bavarian State railways employ wireless telegraphy for sending instructions from signal boxes to approaching trains. The experiments which have been made so far have proven highly successful.

A SOUTHERN MACHINE REPAIR SHOP.

A country machine repair shop is generally of interest to the mechanic; it is a place where ingenuity, enterprise and resource are commonly developed to an extent seldom met with in much more pretentious manufacturing shops. The work that comes to it is generally of an emergency nature requiring instant decision and quick action. Its motto is, or should be, "get there, and do it quick." Instructions from owners are usually indefinite and vague, their principal consideration being limiting the cost and the time. Usually there is no precedent, but if the work is not satisfactory there will always be a hereafter. An engine, for example, must be made to run a few weeks longer; it needs a thorough overhauling, or what is more likely, relegation to the scrap heap, but the proprietor can spare neither the time nor money at the present for thorough repair or replacement. The present machine must be made to run somehow, and that somehow is up to the repair man. Long hours and undesirable work are the rule, but the work nevertheless has its compensations to those who love it.

Down South in Dickey, Ga., is one of these repair shops, typical in meeting all the demands of the country round about, having the reputation for first-class work and unique in having for one of its principal all-around mechanics a woman of resource and mechanical ability equal to almost any emergency. The shop is that of Mr. Eugene P. Parkins, and his wife is his principal helper. Mr. Parkins was born in Champaign, Ill., forty years ago; his father moved to Atlanta, Ga., when he was but a lad. In 1879 his father bought a plantation in the southwestern part of the State, and moved there with his family. Among other improvements which he made was the installation of a cotton gin, driven by a small engine and boiler. In 1883 the son left the farm, for he was never satisfied there except when the engine and boiler were in operation. He entered the repair shops of the Western & Atlantic R. R. as an apprentice and stayed there five years. Then with his savings he equipped his first machine shop, which was built back on the old home farm, adjoining the gin house. The boiler and engine which used to run the gin furnished the power to run the shop. The first tool equipment consisted of of a 16-inch by 8-foot bed Perkins lathe, and a 10-inch crank shaper, a small drill press, a grindstone, together with such small tools as he could afford to buy, including stocks and dies for threading pipe, screw plate, taps and dies, etc.

The building of a shop in the heart of the "piney woods" fourteen miles from a railroad was "a seven-day wonder" and everyone, without exception, predicted failure, but the proprietor was not ambitious beyond what he could clearly see, and he saw the chance to build up a good business with perseverance and first-class work. This has always been his hobby—the turning out of first-class work. When the shop was first built the people in this section of the country had to send their work to Macon, over 100 miles distant, or to Montgomery, equally as far. Hence the shop was a great boon to the locality. There were innumerable cotton gins and saw mills in the locality and the owners of these soon learned the road "to Parkins."

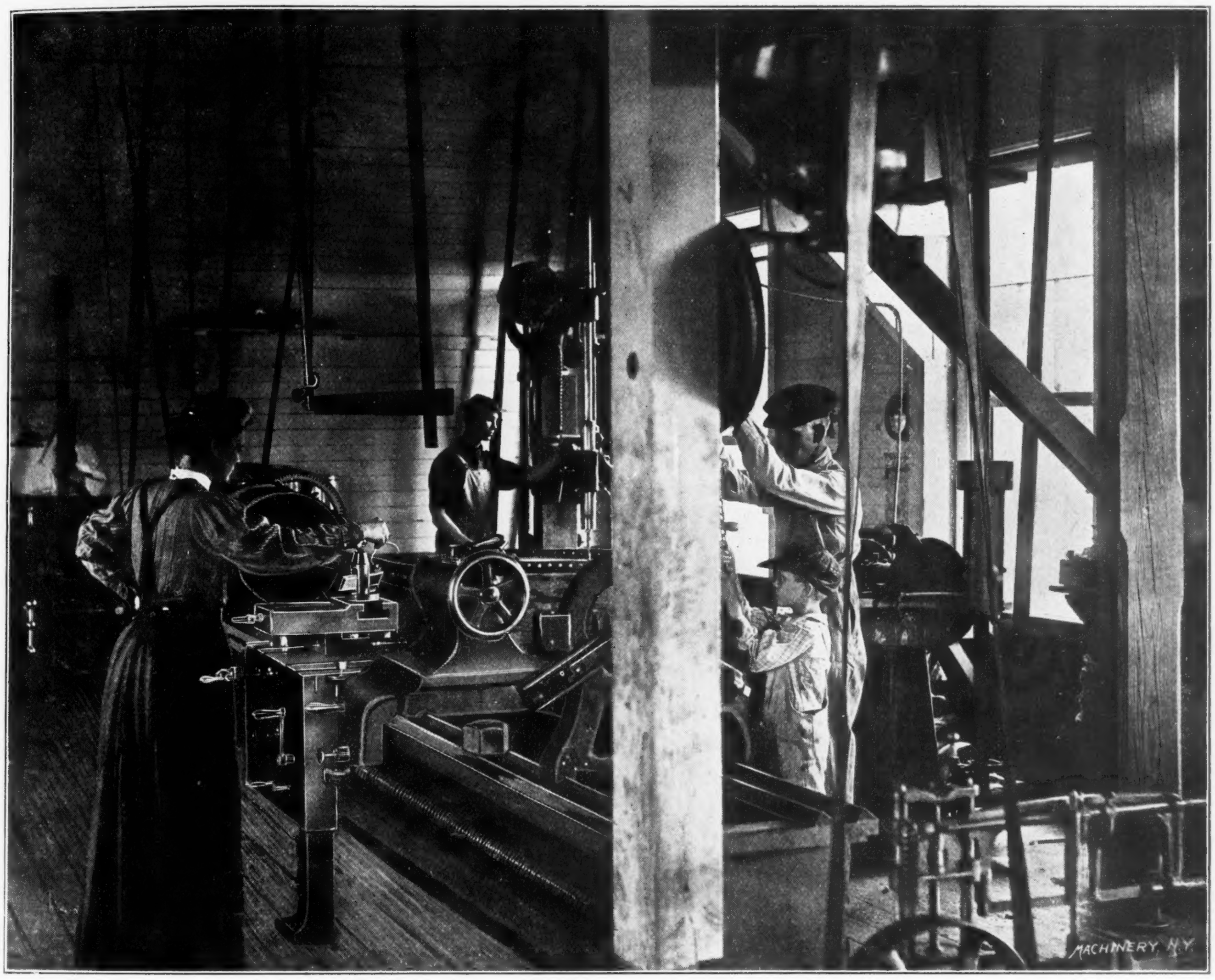


Fig. 1. A Southern Machine Shop; All Hands at Work; Mrs. Parkins Turning a Piston Rod

As time passed Mr. Parkins saw the need of more tools and larger machinery, which were added from time to time as his business warranted the expenditure. The shop really built and equipped itself from the very start, all the machinery having been purchased from the earnings. In 1891 Mr. Parkins married a young lady in Washington, D. C., who at that time was stenographer, typewriter, bookkeeper, etc., to one of the prominent business men of that city, a man who afterward was one of the commissioners of the District of Columbia. Soon after his marriage, Mr. Parkins built a new

and larger shop and his dwelling house was attached. In fact, the shop and home are under one roof. This proved to be a most satisfactory arrangement, because Mrs. Parkins now spends a large part of her time in the shop as a general all-around helper to her husband. At first she would take her sewing to the shop for "company's sake." Then, having a natural taste for the intricacies of machinery, she became interested in the work and would cften take hold and do some simple job. Now she is a full-fledged machinist and carries on the work in her husband's absence. In fact, last summer she ran the shop every day for three months, doing all the work as it was brought, with the assistance of an apprentice and her son, and she has never had to turn away a piece of work yet because she did not know how to do it. The general class of work which comes to the shop is principally engine repairs. The work in which she particularly excels is the reboring of cylinders, making new pistons complete, including head rod and rings, planing and fitting rod brasses, planing valve seats, repairing injectors, etc. Many of these jobs are done from start to finish without any assistance whatever from Mr. Parkins, and, in fact, many of them he never sees from the time they come into the shop until they

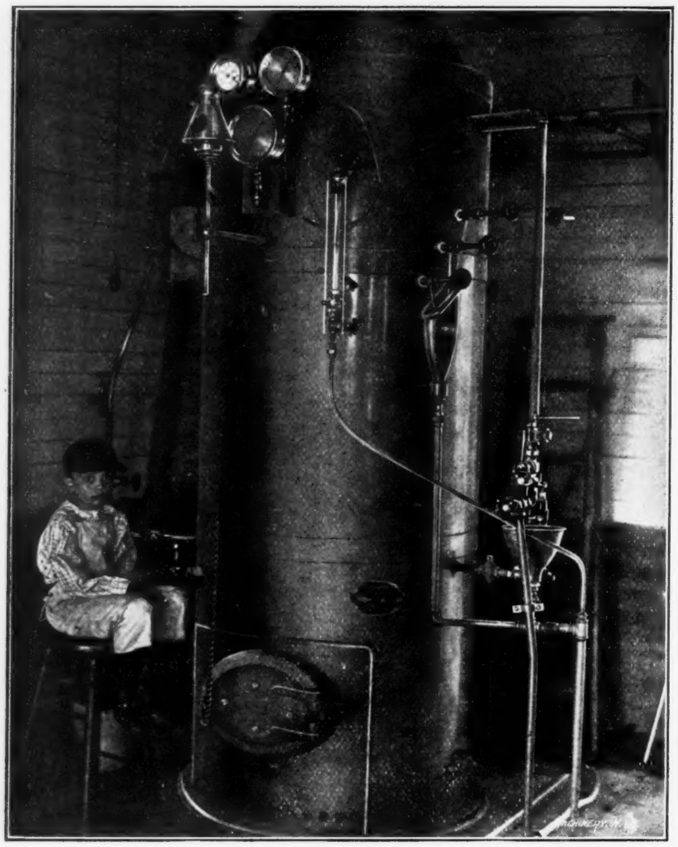


Fig. 2. The Boiler and the "Fireman."

leave, ready fcr business. The normal shop force consists of Mr. and Mrs. Parkins, a 16-year-cld apprentice, and her seven-year-old son, who is the fireman.

After Mr. Parkins had been in business a year or two he found that he must learn boilermaking as an extra trade, for he was frequently called upon to repair boilers as well as engines. At first he would send to Macon for a regular boilermaker to do the work, but by watching the work and helping under directions he soon "caught on" to the principles involved, and then it was only experience and practice that were required. To-day he is a competent boilermaker, able to do all the repair work of this kind that comes his way. He keeps in stock boiler steel for patches, patch bolts, all sizes of rivets, and all boiler tools, such as flue expanders, staybolt taps, patch-bolt taps, and, in fact, any tool or chisel necessary for turning out a first-class job.

The present equipment of the shop consists of a Hamilton lathe, 26-inch swing by 16-foot bed, with quick-change gear screw cutting attachment; the small Perkins lathe before mentioned, which "built the shop"; a 32-inch Steptoe gear shaper; a 30-inch drill press, with power feed; emery grinder with two wheels, wet and dry; and a power hack-saw. Besides, there is a splendid equipment of all small tools necessary to turn out strictly first-class work, such as drills, reamers, taps, screw-plates, files, chisels, dies for threading pipe up to 3 inches, the larger threads being cut in the lathe. All lathe and shop tools are of the inserted cutter type, the old forged type having been discarded long ago.

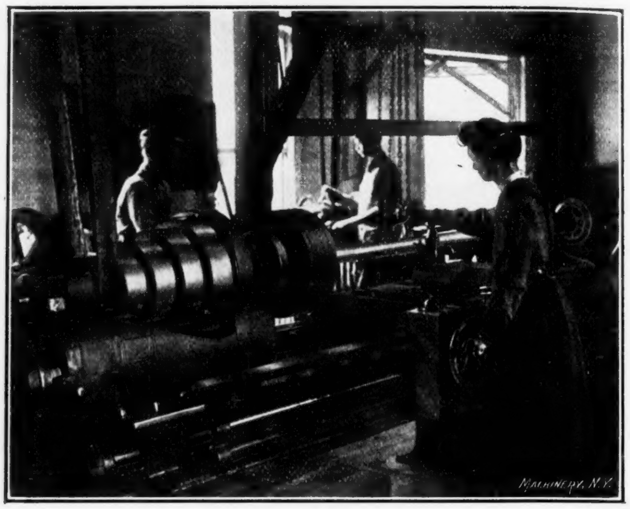


Fig. 3. Another View of the Shop. Note the Business-like Attitude of the Lady Machinist.

An important branch of the business is the repairing of inspirators and injectors, the Hancock and Penberthy instruments being the favorite boiler feeders in that section. A full line of repairs is kept in stock for each of the above-mentioned types, besides reamers and other tools for reseating worn valve seats and putting them into working order as good as when new. This work is almost entirely attended to by the lady machinist.

A few years ago a railroad was built within six miles of the shop, which opened up the surrounding country to a great extent, and work is now brought to the Parkins shop from miles around, coming in many cases from railroad towns where it could be shipped direct to machine shops in the larger towns, but the common saying is: "Tne people want a Parkins job."

Water is furnished for the boiler from a well about 60 feet deep, the water being pumped into a steel tank 6 feet in diameter and 10 feet high, located on top of a 90-foot tower, by a Marsh deep well pump, 6-inch cylinder by 36-inch stroke. This

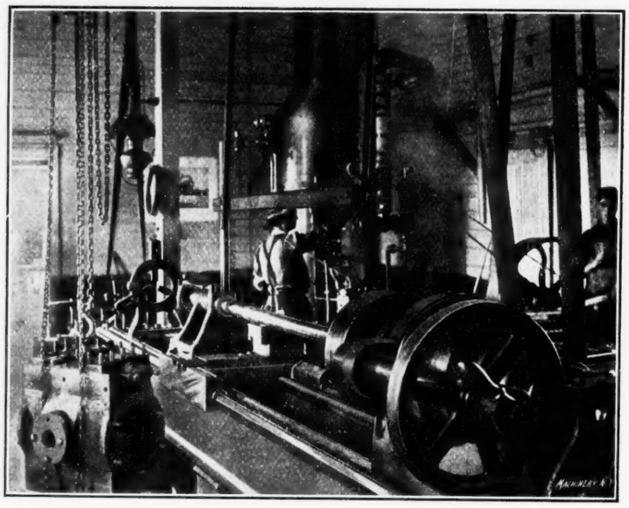


Fig. 4. The Boiler needs a little Attention.

tank also furnishes water for the house which, by the way, is fitted up with all modern city conveniences. Connected to the supply pipe from the tank is 100 feet of 2-inch fire hose, which gives first-class fire protection. The height of the tank insures a pressure which will throw a stream of water clear over any of the buildings.

Being so far from the base of supplies, the shop is obliged

to keep on hand a large stock of supplies, including many parts which the ordinary city shop would not carry; this stock includes, besides the usual supplies, many castings of the machinery used in the vicinity.

* * *

The time when the territory for great engineering feats was limited to America and Europe is past. Recent reports of the progress of the tremendous undertaking of the building

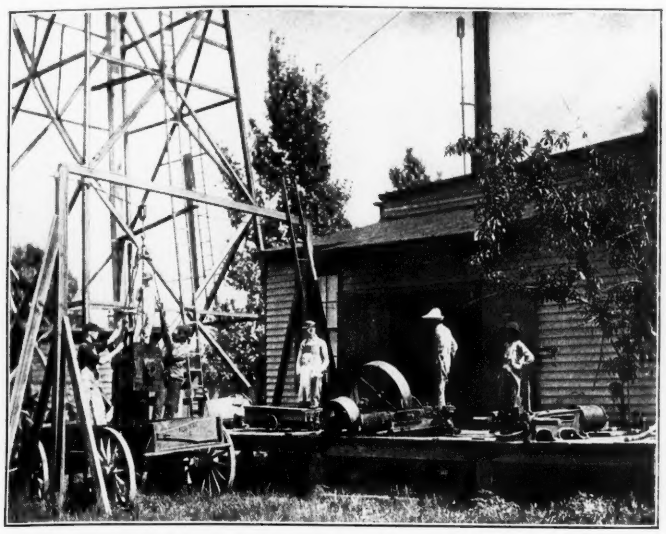


Fig. 5. Shipping a Repaired Job.

of a railroad from Cairo to Cape Town indicate that the work is rapidly being carried to completion. Last June the northern branch had reached within 400 miles of the Victoria Falls, and of the southern branch 2,000 miles are already completed. Between three or four thousand natives are regularly employed in the construction work. The last portion of 300

Fig. 6. The Home Part of the Shop and the Water Works.

miles, with seven bridges of more than 50 feet span, was completed in less than a year. From China is reported the completion of an enormous railroad bridge over the Yellow River, said to be the greatest undertaking of modern engineering in that country. The bridge is about 10,000 feet long, and consists of 103 spans, each varying in length between 75 and 110 feet.

TRACING, LETTERING AND MOUNTING.—2.

I. G. BAYLEY.

Tracing (Continued).

Sectioning.—Sections are shown in several ways. For working tracings line sectioning is far the better. Plates and sections in wrought iron or steel work may be blackened, as shown in Fig. 7. A narrow white space should be left between two pieces, as shown.

A pretty way of showing sections, especially in the case of show tracings, is to represent the various metals, woods, etc., by broken and full lines shown in Fig. 8. The examples are standard, although in case there should be any doubt as to whether they will be generally understood it would be well to make a small note to one side, naming the metal.

A neat little tool for section lining is easily made from a slip of wood a little thicker than the triangle or set square used by the draftsman, illustrated in Fig. 9. The notch cut in one side is a little longer than the side of the triangle. Resting the thumb upon the T-square, the first finger upon the sectioner and the second finger (all of the left hand) upon the triangle, they are alternately slipped along each time a line is drawn with the pen. With a little practice, sectioning can be done quicker than by using a triangle and T-square only, trusting to the eye for correct spacing. Section lining done this way looks very neat and even. Another section liner shown in Fig. 10 can be made to fit triangles having a recess in the center.

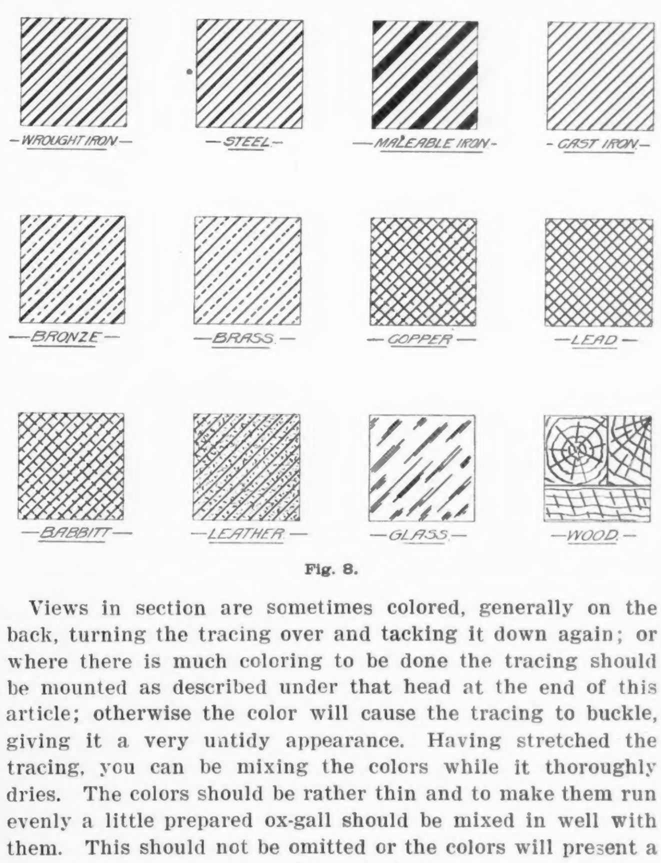


Fig. 8.

Views in section are sometimes colored, generally on the back, turning the tracing over and tacking it down again; or where there is much coloring to be done the tracing should be mounted as described under that head at the end of this article; otherwise the color will cause the tracing to buckle, giving it a very untidy appearance. Having stretched the tracing, you can be mixing the colors while it thoroughly dries. The colors should be rather thin and to make them run evenly a little prepared ox-gall should be mixed in well with them. This should not be omitted or the colors will present a very smudgy appearance. Some draftsmen use a small piece of soap in place of the ox-gall.

By trying the colors upon a scrap piece of tracing cloth or paper and turning it over, the proper shade may be obtained.

Following is a list of representative colors used in many offices:

Cast iron	Payne's gray.
Wrought iron	Prussian blue.
Steel	Crimson lake and small quantity of blue.
Brass	Yellow.
Copper	Crimson lake and yellow.
Brick	Crimson lake.
Wood	Burnt sienna.
Earth	Daubs of ink, Payne's gray, etc.

In the absence of Payne's gray a pale wash of India ink in

which has been mixed a little Prussian blue may be substituted.

Very neat sectioning can be made with crayons, toning them down with a soft rubber.

Dimensions and Center Lines.—Working tracings should have the dimension lines, center lines and all lines black ink, the idea being to make a neat, distinct tracing for use only, whereas a show or estimate tracing should be made with greater care. It is a well-known fact that many contracts have been awarded on the merits of a well-executed piece of work by the draftsman. The time and expense spent upon making a neat show tracing is never lost. Make the center lines of red ink or color, a fine long dash and dot line; the dimension lines one continuous line broken only where the figures come. See Fig. 11.

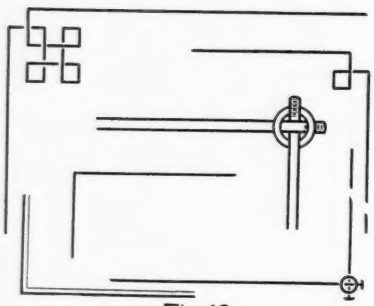


Fig. 12

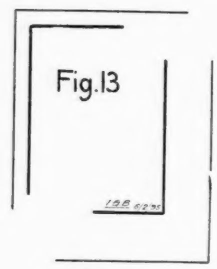


Fig. 13

Fig. 14

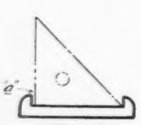


Fig. 9

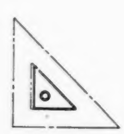


Fig. 10

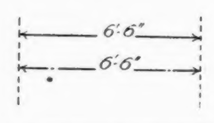


Fig. 11

Border and Cutting-Off Lines.—Simple as these may seem, yet many well-executed tracings have been spoiled by either neglecting a border line or making a very poor one. A one-line border is perhaps the best and its thickness should match the work in hand, together with the size of the sheet. There should be plenty of margin between the border line and the

Fig. 7

Fig. 15

Fig. 16

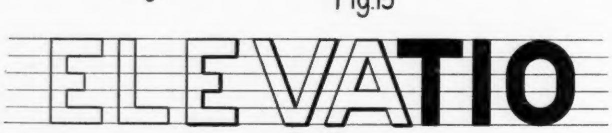


Fig. 18

Fig. 19

work. A fancy border line may be put around estimate or show tracings, of which a few samples are given in Fig. 12.

The cutting-off line should not be too near the border line, say, from ¾ inch to 1 inch. Nothing looks worse than to see a good tracing spoiled by cutting off within a quarter of an inch of the border line. Compare Figs. 13 and 14. The initials of the draftsman and date tracing was made should not be omitted.

Conclusion.—Attention to details is perhaps the true secret of making a neat tracing. No matter how trifling a detail may seem, it should be made as neatly as the rest of the work. Channels, angles, etc., in section should be made accurately. See Fig. 16. Don't make them, as is so often done, like Fig. 15.

When tracing a blueprint the tracing should be tacked down with few tacks, as it will have to be lifted quite often to see the work distinctly; in fact, in many cases it would pay to make a drawing from the blueprint and trace it.

Drawings which are faint or unfinished should by all means be made clear before attempting to trace them, thereby saving much patience, but in particular the eyesight.

In tracing from another tracing, a clean sheet of white drawing paper underneath will make it stand out clearly.

If the draftsman understands what he is tracing, the work will be much easier and he will not be likely to make so many mistakes as he would if tracing a number of meaningless lines.

The tracing should be wiped down occasionally with a clean, dry duster or cloth. Cotton sleeves are sometimes used to protect the coat. A sponge-rubber or piece of bread may be used to clean a tracing, but if proper care has been taken, a tracing can be taken up as clean and neat as when tacked down. A creased soiled tracing shows a bad workman. In some offices it is the practice to sponge the tracings down with benzine. Waterproof ink must be used by all means if this plan is adopted. When the tracing is complete, the draftsman should look over it carefully, trying to detect any errors, as all such count against him. The shop hands, as a rule, are only too pleased to point out any trifling mistake coming from the drawing office. However, accuracy as well as neatness and quickness is desirable

Lettering.

No matter how neatly or carefully the working lines of a tracing are made, if the lettering and figures are not up to the mark, the tracing will look poor in every sense of the word.

The young draftsman should, therefore, take especial care to get into a neat way of lettering and should devote a little

POSITION OF CYLINDERS.
STARBOARD ENGINES.
QUADRUPLE EXPANSION ENGS.
24-36-51½-74 × 42. NOS. 218-19-20-21.
THE GLOBE IRON WORKS CO.Y.
CLEVELAND. OHIO.
SCALE ⅜"-1'-0" JUNE 6TH 1890.

Fig. 17.

of his spare time each day to this end if he wishes to excel as a neat draftsman. Neat letterers are in demand and are always sure of a position. Many cases have come to the writer's notice where a good letterer has been employed in his spare time to put on the figures and letters of other men's work, and although a poor tracing can be improved by neat lettering, to excel in both should be everyone's desire.

A good instruction book on this subject is difficult to find. Most alphabet books are ridiculous in the extreme; it would take longer to make the letters they describe than the whole tracing. The tracings would look insignificant in comparison with the wonderful lettering.

The letters and figures must conform to the other work—neither should be more conspicuous than the other. For this reason it is preferable for each man to complete his own tracing.

It is an easy matter to tell who made the various tracings in most drawing offices by the peculiar characteristics of each draftsman—this one by its poor lettering or that by a beautiful harmony of lines, letters and figures, the whole standing out in correct proportion, fine lines having small neat figuring, lettering, and arrow points to match, or heavy lines *vice versa.*

Nothing looks more uniform, neater, or is quicker done than good, plain, one-line lettering, even for the titles, though perhaps a little display may be given to them.

A few samples are here given. The small letters are for the general working parts of the tracings, notes, etc. Headings should be a little larger and the title, which will be referred to later, should be distinguished from the rest of the

work by using larger letters either blocked out or capital letters made with a heavier pen.

Figures should be made plain and simple, without the use of flourish or tailpiece. Fractions should be made with one figure immediately over the other instead of to one side. The vertical system of figuring is preferable to the slanting, especially with shop tracings.

Fig. 20. Examples of Lettering.

For lettering, have plenty of black ink, but not too thick. The best kind of pen points are Esterbrook's No. 333 or Gillot's 303 for fine work. A heavier pen must be used for titles. Make the letters and figures with one stroke of the pen; do not go over them again, but get the required thickness, even with titles, by bearing on the pen more. A pen can be tempered when new by holding it in a lighted match, though pressing it on the thumbnail is generally sufficient.

Headings or Titles.—The heading or title should be in a conspicuous place, and as far from anything which may tend to crowd it as possible. The bottom right-hand corner of the

Fig. 21. Examples of Lettering.

sheet is a good place. A heading sometimes looks better without lines drawn underneath, as shown in Fig. 17. This is entirely optional, however; if lines are put under they should not be too close to the letters.

Black letters are sometimes used, which can be made by drawing six pencil lines equally spaced, as shown in Fig. 18. The T-square and triangle are used and the letters can be made quite rapidly. They should afterwards be filled in or one edge of the letters made heavier, according to the nature of work in hand. Sloping letters can be made in the same way by using an adjustable-headed T-square or a special triangle made for that purpose.

Stenciling.—Sometimes headings, letters, figures and corner pieces are put on by means of stencil plates cut out of tin or copper sheets. A stiff, short stencil brush is used. The brush is moistened with water, not using too much, and is then rubbed along the stick of ink until it cannot absorb any more. Particular attention is called to this, as here is where so many fail in making clean and clear stencil work; the brush should never be dipped into a saucer of ink, or the ink applied with a pen.

The position for the title having been settled, pencil lines should be drawn on the cloth as a guide for the stenciling. Sometimes the title or heading is stenciled upon a spare piece of cloth or paper first, then slipped into place under the tracing and the stencil work done over it. This is a good plan, as the correct position may thus be obtained. If this is not done, the only way is to make a pencil tick mark after each letter to indicate the position of the next, as, of course, the stencil plate will hide all beneath it except the letter being stenciled. Then the letters must each be filled in, as shown in the first two or three letters of Fig. 19.

Even when the stencil guide referred to is made and slipped into place under the tracing cloth, a pencil guide line should be drawn and all letters stenciled exactly to it. The pencil lines and ticks are then erased. If the brush becomes dry, it may be moistened on the tongue without again rubbing it on the ink stick.

Draftsmen sometimes cut their own stencil plates out of stiff drawing paper, applying a coat of varnish on the upper surface.

Round Writing.—When referring to alphabet books, the writer should have made one exception at least, and that is the round writing system. It is easily learned and not soon forgotten. Letters and figures of all sizes and shapes can be made by using different graded pens. Books of instruction and an assorted box of pens may be had from any stationery store of importance. It is known as the Round Writing System of Lettering.

* * *

Designers, in general, in making use of malleable iron castings, proceed without definite knowledge as to the physical properties of this material, so far at least, as its tensile strength and elongation are concerned. Mr. G. A. Ackerlind read before the Scandinavian Technical Society recently a paper in which he gave some definite information as to the properties of malleable cast iron as made in that country. This information is doubtless applicable to American irons as well. He states that the tensile strength for this material varies between 40,000 pounds and 50,000 pounds per square inch. It has an elongation varying from 1 to 6 per cent with a reduction of area of 3/4 to 3 per cent. The ordinary grade of cast iron having a tensile strength from 20,000 to 30,000 pounds per square inch is therefore only about half as strong as malleable cast iron; its compressive strength, however, is much greater. Malleable cast iron shrinks more in the mold than cast iron, but during the process of annealing a slight swelling takes place. If malleable castings have to be straightened by hammering, nothing is gained by heating them, the normal temperature of the surrounding air being satisfactory for this purpose.

THE CONDITIONS OF FAN BLOWER DESIGN.

The velocity with which air escapes into the atmosphere from a reservoir is dependent upon the pressure therein maintained and upon the density of the air. The pressure per unit of area divided by the density per unit of volume gives the head, usually designated as the "head due to the velocity." The velocity produced is that which would result if a body should fall freely through a distance equal to this head. In the case of the flow of water such a head always exists; as, for instance, when a stand-pipe is employed to produce the requisite pressure. Suppose the head of water to be 50 feet and its weight per cubic foot to be 62.5 pounds, then the pressure per square foot will be $50 \times 62.5 = 3{,}125$, and that per square inch $3{,}125 \div 144 = 21.7$ pounds. Its theoretical velocity of flow from an orifice at the bottom of the standpipe would be 56.7 feet per second, as determined by the formula for falling bodies, which is $v = \sqrt{2gh}$, in which

v = velocity in feet per second.

g = acceleration due to gravity.

h = head in feet, here 50 feet.

In the case of air, however, an actual homogeneous head never exists, but in its stead we have to deal with an ideal head which can only be determined by dividing the pressure by the density. As the density of air is so much less than that of water, it is evident that for a given pressure the head will be far greater in the case of air. But the velocity of discharge is dependent only on the distance fallen which is represented by the head, whether real or ideal. As a consequence, air under a stated pressure escapes at vastly higher velocity than water under the same conditions. Calculated in the same manner the velocity of escaping air under a pressure of 21.7 pounds per square inch is 1,626 feet per second. By the employment of formulas based upon this theory, the elaborate basis tables published by the B. F. Sturtevant Co. have been calculated.

From the preceding discussion, it is evident that the pressure created by a given fan varies as the square of its speed. That is, doubling the speed increases the pressure four-fold. The volume of air delivered is, however, practically constant per revolution, and therefore is directly proportional to the speed.

The work done by a fan in moving air is represented by the distance through which the total pressure is exerted in a given time. As ordinarily expressed in foot-pounds, the work per second would, therefore, be the product of the velocity of the air in feet per second, the pressure in pounds per square foot, and the effective area in square feet over which the pressure is exerted.

From this it is evident that the work done varies as the cube of the velocity, or as the cube of the revolutions of the fan. That is, eight times the power is required at twice the speed. The reason is evident in the fact that the pressure increases as the square of the velocity, while the velocity itself coincidently increases; hence, the product of these two factors of the power required is indicated by the cube of the velocity.

The actual work which a fan may accomplish must depend not only on its proportions, but upon the conditions of its operation and the resistances which are to be overcome. Evidently, it is improper to compare fans when operating under such conditions that these resistances cannot be definitely determined. The simplest and most natural condition of operation is that in which the fan is operated without other resistance than that of the case; that is, with open inlet and outlet. For proper comparison of different fans, the areas through which the air is charged should bear some constant relation to the dimensions of the wheels themselves.

It has been determined experimentally that a peripheral discharge fan, if enclosed in a case, has the ability, if driven at a certain speed, to maintain the pressure corresponding to its tip velocity over an effective area which is usually denominated the "square inches of blast." This area is the limit of its capacity to maintain the given pressure. If it be increased the pressure will be reduced, but if decreased the pressure will remain the same. As fan housings are usually constructed, this area is considerably less than that of either the regular inlet or outlet. It, therefore, becomes necessary, in comparing fans upon this basis, to provide either the inlet or the outlet with a special temporary orifice of the requisite area and the proper shape, and make proper correction for the contracted vein. The fan is thus, in a sense, placed in a condition of restriction of discharge, which it approaches in practice only in so far as the resistance of pipes, passages and material through which the air must pass has the effect of reducing the free inlet or outlet of the fan.

The square inches of blast, or, as it may be termed, the capacity area of a closed fan, may be approximately expressed by the empirical formula:

$$\text{Capacity area} = \frac{DW}{x}$$

in which D = diameter of fan wheel, in inches.

W = width of fan wheel at circumference, in inches.

x = a constant, dependent upon the type of fan and casing.

The value of x has been very carefully determined by the B. F. Sturtevant Company for different types of fans; but these values must be applied with great discretion, acquired through experience and a thorough knowledge of all the conditions liable to affect the fan in operation.

* * *

BRITISH STANDARD FINE SCREW THREAD.

The committee on screw threads and limit gages, a subcommittee of the Engineering Standards Committee supported by several engineering institutions in Great Britain, recommends the continuation of the use of the Whitworth form of thread as the British standard for screws ¼ inch and larger in diameter. For screws smaller than ¼ inch in diameter the committee recommends the adoption of the British Association form of thread with the same pitches as are now known as the British Association's standard (B. A.).

In regard to the pitches for screws ¼ inch and larger in diameter, the committee recommends the adoption of two standards. One of these is to be known as the British Standard Whitworth Screw Thread (B. S. W.), and retains the same number of threads per inch as is now in use in the regular Whitworth's system. The other standard proposed has a greater number of threads per inch for corresponding diameters and will be known as the British Standard Fine Screw Thread (B. S. F.)

The reason for adopting this latter standard was founded on the complaints of many manufacturers that the regular Whitworth standard gave altogether too coarse pitches for a number of purposes, and while the old system was well adapted for a variety of constructions, it was not the best obtainable for such designs where shocks and vibrations had to be taken in consideration.

The pitches for the system of fine screw threads are based on the formula:

$$P = \frac{\sqrt[3]{d^2}}{10}$$

for sizes up to and including one inch; and on the formula

$$P = \frac{\sqrt[8]{d^5}}{10}$$

for sizes larger than one inch in diameter. In the above formulas

P = pitch, or lead of single-threaded screw, and

d = diameter of screw.

A table giving diameters and corresponding number of threads per inch will be found below.

BRITISH STANDARD FINE SCREW THREAD.

Diam.	No. of Threads per in.	Diam.	No. of Threads per in.	Diam.	No. of Threads per in.	Diam.	No. of Threads per in.
$\frac{1}{4}$	25	$\frac{5}{8}$–$\frac{11}{16}$	14	$1\frac{3}{8}$–$1\frac{5}{8}$	8	$4\frac{1}{4}$–$5\frac{1}{8}$	4
$\frac{5}{16}$	22	$\frac{3}{4}$–$\frac{13}{16}$	12	$1\frac{3}{4}$–$2\frac{1}{8}$	7	$5\frac{1}{4}$–6	$3\frac{1}{2}$
$\frac{3}{8}$	20	$\frac{7}{8}$–$\frac{15}{16}$	11	$2\frac{1}{4}$–$2\frac{7}{8}$	6	.....	..
$\frac{7}{16}$	18	1	10	3–$3\frac{3}{8}$	5	.....	..
$\frac{1}{2}$–$\frac{9}{16}$	16	$1\frac{1}{8}$–$1\frac{1}{4}$	9	$3\frac{1}{2}$–$4\frac{1}{8}$	$4\frac{1}{2}$	.....	..

* * *

The output of asbestos in the United States for 1905 was 3,109 short tons.

ITEMS OF MECHANICAL INTEREST.

A RAT'S TRY AT HYDRAULIC ENGINEERING.

The rodent dwellers in the floors and partitions of an apartment building in Brooklyn attempted to make a passageway from their quarters on one side of a floor beam by gnawing through to the other side. They succeeded in their undertaking, as the people living in the flat below this floor discovered when deluged by a flood of water from above. The rats gnawed through the beam in a diagonal direction and encountered on the further side of the beam a lead water pipe in which there was the city water pressure. The pipe ran parallel with the beam and was so located that the rats were obliged to gnaw through it in order to gain a passage way. They continued in their diagonal course, however, eating away the pipe, as shown in the illustration, in spite of the large

The Pipe after the Job was Completed.

volume of water escaping. It was a job that probably made them hold their breath. The pipe was brought us by the engineer of the building as evidence of a good piece of hydraulic engineering and incidentally as an indication of the multifarious duties that fall to the lot of one in his position.

FRICTIONAL FEED MOTIONS

The principle used in the jeweler's drop hammer, by which a man is apparently able to lift a great weight by placing his foot in the stirrup at the end of the strap to which the drop is attached, has another application, as shown in the cut herewith. In the case of the drop hammer the strap passes over a rotating pulley at the top of the press. The pressure of the operator's foot in the stirrup draws the strap tight enough over the pulley so that the latter raises the drop through frictional contact.

The illustration, Fig. 1, shows this lifting device, as used by the New Britain Machine Co., New Britain, Conn., for raising the table of their mortising machine to bring the work against the cutters. This lifting motion is an instance of a device almost elementary in its simplicity, yet exactly meeting and accomplishing a variety of requirements. The frictional strap which raises the table passes over the pulley *B* which rotates in the direction of the arrow. One end of the

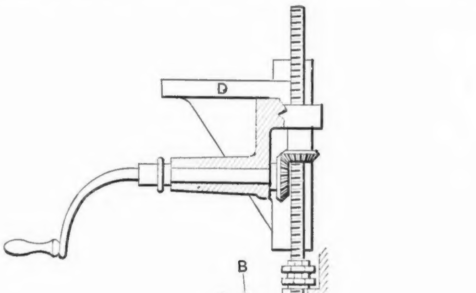


Fig. 1. Friction Feed Device for Mortising Machine.

strap is attached to the treadle, *A*, and the other end to the vertical screw, *C*, by which the table, *D*, is raised or lowered. A slight pressure of the foot upon the treadle results in a lifting force many times as great upon the table and even the greatest pressure cannot cause the table to exceed the rate of travel fixed at the feed cones. A light pressure slows the feed rate for hard spots and the natural weight of the foot on the treadle acts as a cushion when the table drops.

The frictional pulley used for raising the tables in these mortisers appears in section at *A*, Fig. 2, which also illustrates a novel method of clamping the pulley to the shaft, *B*, without the use of set screws. The requirements are such that the shaft cannot have a shoulder against which to clamp the pulley by means of a nut on the end of the shaft; and as it is necessary for the pulley to be removable, the method

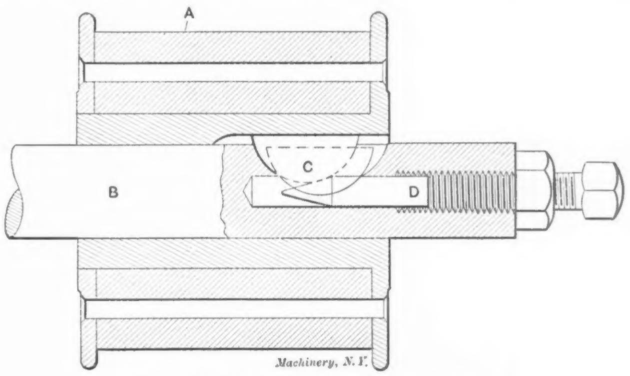
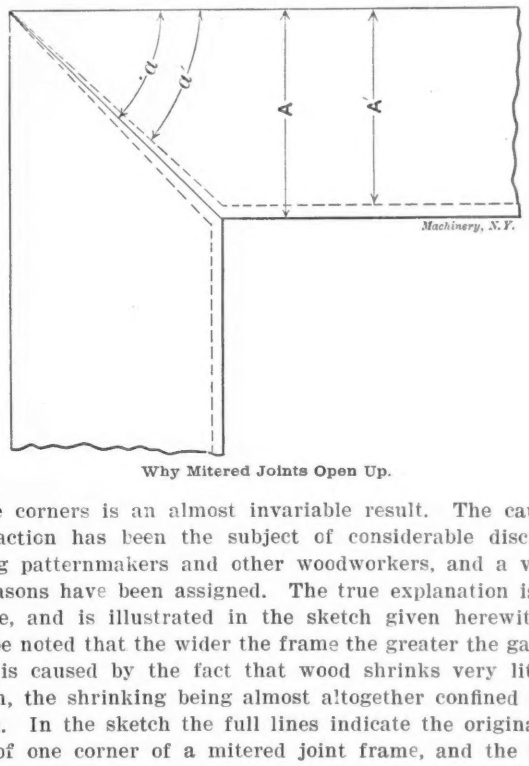


Fig. 2. Method of Holding Pulley to Shaft.

shown in the sketch was devised for holding it. A Woodworth key, *C*, is used, and this is forced out against the keyway milled in the bore of the pulley by means of a set screw, *D*, which enters a threaded hole in the end of the shaft.

CAUSE OF MITERED JOINTS DRAWING APART.

Why do the joints of mitered joint frames, such as picture frames, nearly always gap on the inside corners? If the reader will take the trouble to look at a wide picture frame having mitered joints he will find that while the outer corners are close together the inner corners are almost invariably gapping a distance of anywhere from 1-32 to 1-16 inch, or more. When the frame was fitted up a perfect joint, of course, was made, but as the wood seasons the drawing apart of the



Why Mitered Joints Open Up.

inside corners is an almost invariable result. The cause of this action has been the subject of considerable discussion among patternmakers and other woodworkers, and a variety of reasons have been assigned. The true explanation is very simple, and is illustrated in the sketch given herewith. It will be noted that the wider the frame the greater the gapping. This is caused by the fact that wood shrinks very little in length, the shrinking being almost altogether confined to the width. In the sketch the full lines indicate the original outline of one corner of a mitered joint frame, and the dotted lines the shape it takes after having seasoned. Inasmuch as the wood shrinks very little, or not at all, in length it follows that the outside dimensions of the frame remain practically unchanged, but the narrowing of the width *A* to *A'* changes the angle *a* to *a'*, as indicated by the dotted lines, so that the result must be a separation of the joint at the inner corners.

* * *

So long as we see the automobile carrying an extra tire or two, just so long may we regard it as an impractical vehicle for anything save pleasure—pleasure obtained at much cost and trouble.

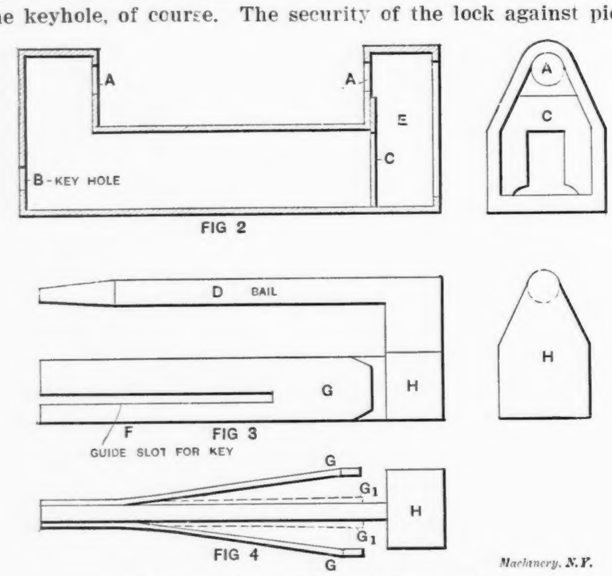
CURIOUS CHINESE LOCK.

Through the courtesy of the Yale & Towne Mfg. Co., we are enabled to present the accompanying halftone, Fig. 1, showing a curious Chinese lock used for some time on a letter box in Doyer St., (within the purlieus of Chinatown) New York. Although of very simple construction and probably easily pickable by an expert, it nevertheless offers a degree of security sufficient for most purposes for which a lock of this type is commonly used. It will be noted that the lock is not only of the spring or self-locking type, but is also of

Fig. 1. A Chinese Padlock and Key.

the ejecting type, the shackle being partially forced out when the key is inserted. It is, we understand, a type of "padlock" largely used in China for trunks, portable boxes, etc.

The arms of the shackle are joined by the part *H* which fits closely in the opening *E* and is flush with the end. One arm of the shackle, it will be noted in Fig. 3, has two spring leaves *G*. These leaves spring outward when the lock is closed and the ends engage the sides of the partition *C*, this constituting the essential locking action. The key is of E-section and its insertion into the lock pinches the spring leaves together, unlocking the shackle and partially ejecting it from the case. The middle projection of the E-section performs no function, being a deception or "blind"; a channel-section key would answer the same purpose but such would not be inferred from the keyhole, of course. The security of the lock against pick-



Figs. 2, 3 and 4. Details of Lock and Key.

ing lies quite largely, however, in the length of the key required, it being nearly three inches long in the working part. For convenience in carrying the key is made with a jointed handle into which it can be closed, as shown in Fig. 1.

The body or shell shown in section in Fig. 2, is made of sheet brass, soldered or sweated together at the corners, and is apparently made up of seven pieces carefully joined. This laborious make-up was doubtless followed in order to avoid the use of castings.

BLANKING AND PIERCING DIES FOR WASHERS.

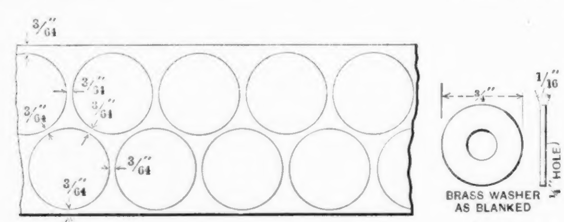
C. F. EMERSON.

One of the simplest dies to make, coming under the head of blanking and piercing dies, is perhaps the die for blanking and piercing brass washers. The reason for this is that in making this die, the file and vise are not used; the construction and shape of this die are such as to allow it to be made by machinery.

To lay out a single washer die is a very easy matter, but to lay out a die for cutting two or more washers at one time, so as to cut the greatest amount of blanks from the least amount of stock, is not understood as it should be.

One of the reasons for this is that it is the custom in some shops to have the foreman, or some one else appointed by him, lay out all the dies before they are given to the die maker to work out.

In laying out a washer die for blanking two or more washers at one time, one of the main points to be remembered is that all the holes from which the blanking and piercing are done must be laid out in an exact relation to each other, so as to



Stock after having been run through the Die in Fig. 2, and Washer made.

eliminate the possibility of "running in" (i. e., cutting imperfect, or half blanks, by cutting into that part of the metal from which blanks have already been cut). The required amount of blanks must also be considered, for it sometimes happens that the amount wanted does not warrant the making of a die that will cut more than one at a time.

Fig. 2 shows how a die is laid out for blanking and piercing two washers at one time, so as to use up as much of the metal as possible. As shown, the ¾-inch holes marked *C* and *D* are the blanking part of the die, while the ¼-inch holes

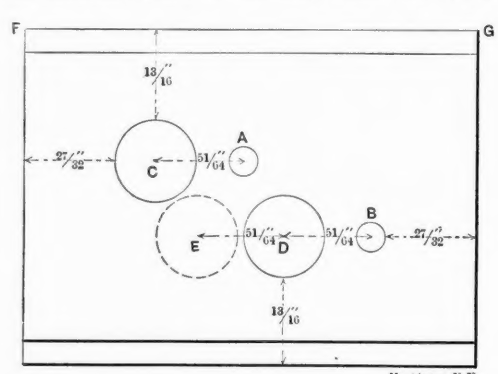


Fig. 2. Plan View of Die for Punching two Washers.

A and *B* are the piercing part. The distance between the center of *C* and *A* is 51-64 inch, as is also the distance between *D* and *B*. By referring to Fig. 1, which shows a section of the stock after it has been run through this die, it will be seen that there is a narrow margin of 3-64 inch of metal, known as "the bridge," between the holes. In laying out the die this margin must be taken into consideration, which is done in this manner. Diameter of washer to be cut plus bridge equals distance from center to center, viz., $\frac{3}{4} + 3/64 = 51/64$.

The dotted circle shows that the die is laid out so that one washer is skipped in running the metal through at the start. This is done in order to make the die a substantial and strong one. It can be very readily seen that if the circle *E* was the blanking part instead of *D*, the die would be a frail one, and would not be strong enough for the work for which it is intended.

Another important point in laying out a die of this kind

is to lay out the die "central," *i. e.*, laying out the die so that when it is keyed in position ready for use in the center of the die bed, it will not have to be shifted to the right or left side in order to make it line up with the punch.

It may not be amiss to say in connection with the above that the punch back which holds the blanking and piercing punches in position should also be laid out "central"; this will be more fully described later on.

Fig. 4 shows the layout for blanking and piercing three washers at one time, and hardly needs any explanation; the explanation given in connection with Fig. 2 sufficiently explains Fig. 4.

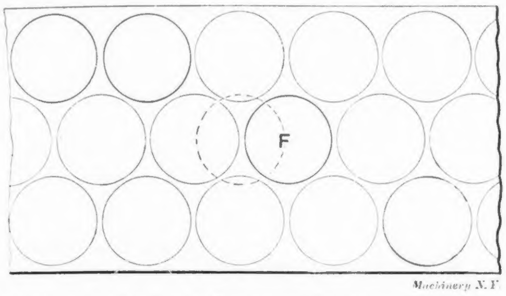


Fig. 3. Stock, after having been run through the Die in Fig. 4.

Fig. 3 shows a section of the stock after it has been run through this die. It can be seen that the holes match in very closely together, and that very little stock is left. It is also seen that the three holes punched are not in a straight line, in so far as the width of the metal is concerned. This is done in order to save metal; the dotted circle *F* is merely drawn to show that wider metal would have to be used if the holes were in a straight line.

Fig. 5 shows the plan of a die for blanking and piercing eight washers at one time. The parts which are numbered are the blanking parts, while the parts that are lettered are the piercing parts of the die. This die is laid out similarly to Fig. 4, with the exception that there is provision for eight blanks instead of for three. Fig. 6 shows a section of stock after it has been run through this die. To give a better idea as to how the blanks are punched out in the manner shown, the sixteen holes in the metal from which blanks have been cut are numbered and lettered the same as the die. It should be understood that the metal is fed through in the usual way, which is from right to left, and that the $\frac{1}{4}$-inch holes are first pierced out, before the $\frac{3}{4}$-inch blanks are cut.

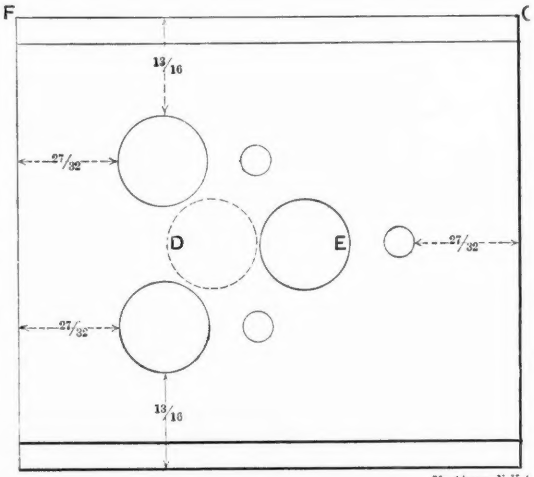


Fig. 4. Plan View of Die for Punching three Washers.

By referring again to Fig. 5, the layout for cutting two, three, four, five, six and seven blanks can be determined. The parts numbered and lettered 1—*A* and 5—*E* are the layout for two blanks. For three blanks: 1—*A*, 2—*B*, and 5—*E*. For four blanks: 1—*A*, 2—*B*, 5—*E*, and 6—*F*. For five blanks: 1—*A*, 2—*B*, 3—*C*, 5—*E*, and 6—*F*. For six blanks: 1—*A*, 2—*B*, 3—*C*, 5—*E*, 6—*F* and 7—*G*. For seven blanks: 1—*A*, 2—*B*, 3—*C*, 4—*D*, 5—*E*, 6—*F*, and 7—*G*.

The die bed used for holding the die in Fig. 5 in position when in use should have its dovetail channel running in the direction *KL*, while the dovetail channel for the dies shown in Fig. 2 and 4 should run in the direction *FG*. The reason for this is the longer bearing surface for the dovetail obtainable by such arrangement.

It should be remembered that all holes in dies of this kind are lapped or ground to size after hardening; they should be perfectly round and have 1 degree clearance. In some shops the holes are left straight for $\frac{1}{4}$ inch, and then tapered off 2 degrees.

An important point to bear in mind in making the punch is to have a perfect "line up." It may not be generally known, but it is nevertheless a fact, that blanking tools that blank, or that pierce and blank two or more blanks at one time, will run longer without sharpening, cut cleaner blanks, and, in fact, give all around better results, if the punches are a perfect "line up" with the die than if they are lined up in the so-called "near enough" way.

Perhaps some one will ask, "What is meant by a perfect line up?"

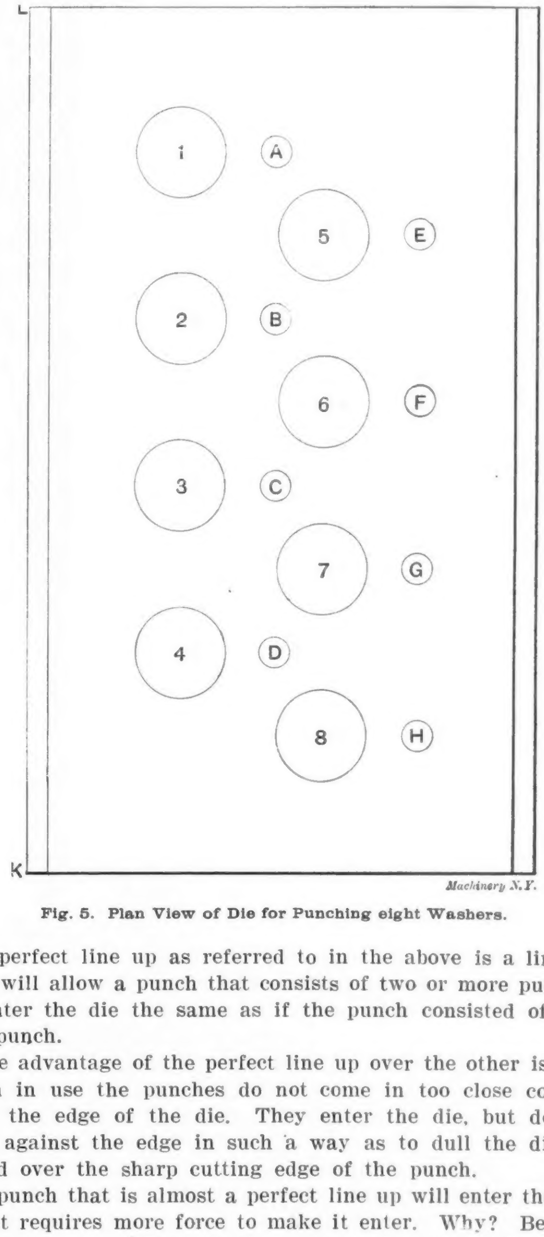


Fig. 5. Plan View of Die for Punching eight Washers.

A perfect line up as referred to in the above is a line up that will allow a punch that consists of two or more punches to enter the die the same as if the punch consisted of just one punch.

The advantage of the perfect line up over the other is that when in use the punches do not come in too close contact with the edge of the die. They enter the die, but do not bear against the edge in such a way as to dull the die, or round over the sharp cutting edge of the punch.

A punch that is almost a perfect line up will enter the die, but it requires more force to make it enter. Why? Because in entering one of the punches for instance, rubs hard against the side of the die, and if set up in the press and allowed to run, that punch, no matter how small, will dull the edges of the die as well as the edge of the punch itself. The result is that the press must stand idle while the tools are being sharpened, and if the real cause of the trouble is not remedied it is "the same old thing" over and over again.

Just a few words in regard to making the punch. In making the punch, the punches must be made so that they will fit the die not too loose, nor too tight. The blanking punches are hardened and ground to size. The taper shank is finished

to size after hardening, so that when the punches are driven into the punch back they will stand straight and not lean to one side.

In laying out the dovetail punch back, first clamp the back central on the face of the die. This is done so that when the punches are driven in position in the punch back, and set central in the ram of the press, ready to be used, no shifting is required in order to make the punch line up with the die, which is keyed in the center of the die bed.

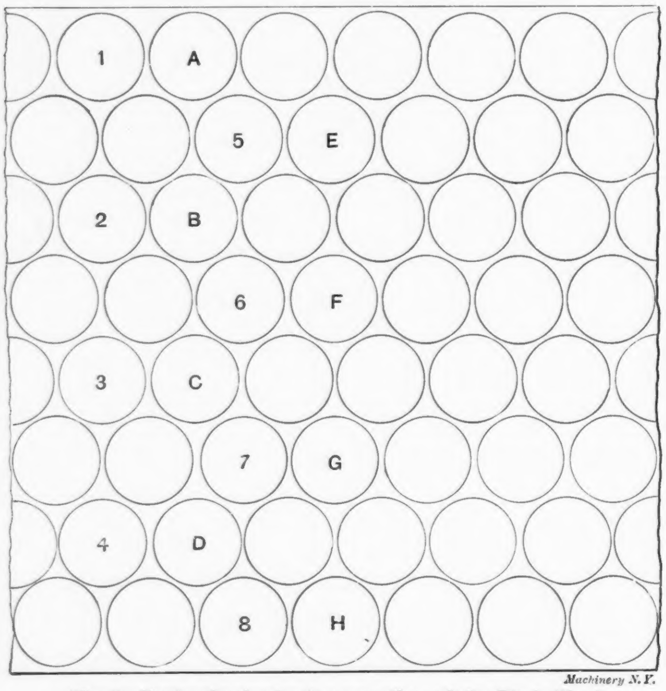


Fig. 6. Stock, after having been run through the Die in Fig. 5.

After clamping the punch back in this position, the blanking part of the die nearest the end is scribed on the face of the punch back. Do not scribe all the holes and rely upon finding the center of each circle thus scribed with a pair of dividers, and then true up these centers on a faceplate in order to get perfect line up; this method increases the chances of error, especially when there are six or eight punches to be set in position. A better way is to scribe one circle as stated

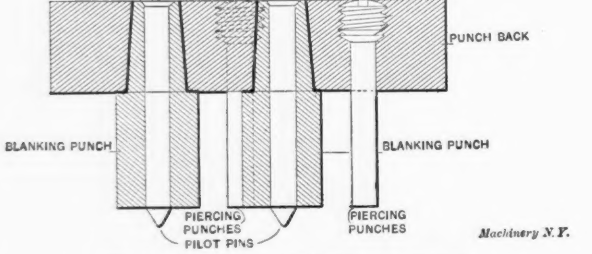


Fig. 7. Punch Back, with Punches Inserted.

above, and remove the punch back from the face of the die; find the center of the circle scribed; true up this center, and drill and bore out the hole to fit the taper shank of the blanking punch.

Fig. 7 shows how a punch of this kind is made. The punch as shown is used with the die shown in Fig. 2. After the hole is bored to size, the already finished blanking punch is driven in tight in the manner shown. Two narrow parallels say $\frac{1}{2} \times \frac{3}{4}$ inch are now laid on the face of the punch back, and the blanking part of the die that corresponds with the punch driven in is slipped over the same, until the face of the blanking die rests upon these parallels, after which the die is clamped tightly thereon. The next hole is now trued up with a test indicator until the hole runs dead true. The die is then removed, and the hole for the taper shank is worked out, and the punch driven in. Where there are more punches to be set in, the same method is used until they are all in position. This insures a perfect line up, providing that ordinary care and precaution has been used in doing the work.

In boring out these holes it is best to use a bolster having a dovetail channel, and to hold the punch back in position with a key.

This is better than using straps to fasten the punch back to the faceplate, as the straps are likely to interfere with the parallels and the die, when locating the exact position for the holes to be bored.

In locating the position for the piercing punches it sometimes happens that the holes are so small that they cannot be bored. The holes are then transferred by a drill that runs true and is the same size as the holes in the piercing die, the die being used, so to speak, as a drill jig.

Fig. 7 shows how the piercing punches are held in position. The punches are made of drill rod, and are prevented from pushing back by hardened blind screws as shown. If thin, soft metal is used, the method for holding the two pilot pins in position shown in the article "Making a Blanking Die," in the June issue, may be employed, or the method shown in Fig. 7.

When the piercing punches are made and held in position as shown in Fig. 7, a spring stripper is sometimes used, and is fastened to the punch back, and the holes for the piercing punches in this stripper are made a sliding fit, in order to prevent the punches from springing or shearing. When the ordinary form of stripper is used, the piercing holes are also made a good sliding fit.

* * *

Spoiled work is probably inevitable in every shop, and it is a considerable problem to handle it in a way that shall be just to the workmen and still protect the interests of the concern. Some men are careless, and if they make a mistake which spoils a piece of work, the incident soon passes out of their minds, and repetitions are common. But it is one thing to make a mistake that spoils a piece of work and another to have it well advertised to the rest of the men in the shop. A conscientious workman earnestly endeavors to avoid spoiling work, and if such a mishap does befall him no one regrets it more than he, and even the most careless, happy-go-lucky chap shares his keen regret to some extent, at least, when the fact is made semi-public in a way that is followed in a certain New York State establishment. Whenever a job is spoiled in this shop it is carefully ticketed with the name of the "spoiler," date, circumstances, cost, etc., and is then prominently exhibited in a so-called "graveyard" for a certain number of weeks, to be there seen and sarcastically commented on by the other workmen. The frantic efforts of these men to avoid this form of "burial" are well worthy of a nobler object, oftentimes, it is said, and it is claimed that salutary effects of the scheme are most marked.

* * *

No improvement in blast furnace practice made in recent years is likely to be of such far-reaching importance as the application of the dry blast, developed by Mr. Gayley. It was discovered that the variations in humidity of the atmosphere were largely responsible for many mysterious troubles in blast furnace practice. The application of the refrigerating principle to the blast so as to reduce the humidity and make it uniform was a long step forward in determining uniform results. A recent example of blast drying apparatus installed is that of the E. & G. Brooks Iron Co., at Birdsboro, Pa. The De La Vergne Machine Co., New York, are putting in refrigerating machinery of 350 tons daily capacity for drying the blast, the air being passed over coils of pipe containing cold brine or ammonia. All excess moisture above a predetermined point is deposited on the pipes, the part remaining being practically constant, so that the humidity of the blast is uniform.

SPRING SCREW THREADING DIES—A CRITICISM.

I was greatly interested in the article in the August number on spring screw threading dies. It struck me as not being written from a practical standpoint, for while most of Mr. Oberg's points are plausibly taken, the difficulties encountered in the use of such dies are somewhat different both in cause and effect from those he enumerates. As one who has had considerable experience in both making and using them, the writer would like to give his views.

In the first place, screw-machine operators who are looking for extreme accuracy in the form of the threads do not use the spring die but prefer the so-called "button" die, which is easy to manufacture and which will give almost faultless results when used on high-grade machines by an experienced man. The chief objection to its use is that it will not stand the abuse which the spring die will and once it is seriously injured cannot be made to do satisfactory work afterward, making the loss on dies heavy when used on rough work or on machines that are abrupt or inaccurate in their movements. A button die would hardly stand up all day threading open-hearth steel with the scale still on, as the writer has seen the other type do.

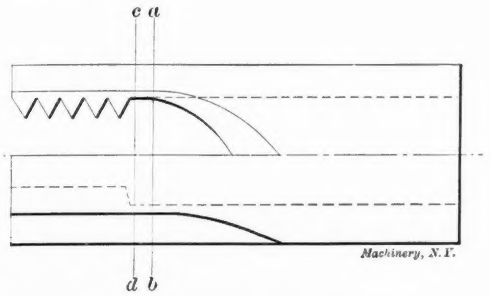


Fig. 1. Spring Screw Threading Die.

Mr. Oberg's method of making the perfect die by taper hobbing from the rear would be all right if we could rely on perfect hardening, but the chances are that when his die came from the hardener it would be no better in lead or form of thread than the die hobbed straight and oversize. If such a die should spring in 0.002 inch say, it would have to be annealed, rehobbed and rehardened with the chance of the same thing happening again, or else lapped out to correct size, which would be a very costly job. A straight die hobbed oversize under the same conditions would still be oversize and could be sprung down. At the same time the error in the form of thread due to springing the prongs down to size need not be over one-third of a thousandth for a 20-pitch thread, an amount which would not be noticed except by an expert gage maker.

Grinding the outside of spring dies is not practicable, and under manufacturing conditions is impossible, as can easily be seen when we take for example a die of ½ inch outside

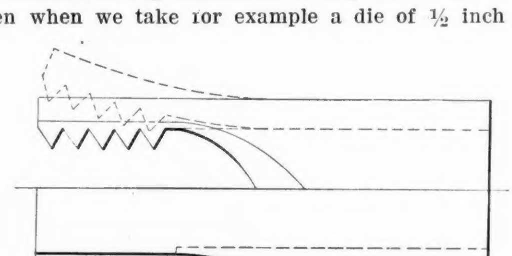


Fig. 2. Effect of Improper Hardening of Spring Screw Threading Dies.

diameter for cutting a 5/32 thread. It would have to be screwed on to a 5/32 threaded arbor with just enough tension to hold it, but not enough to spring the die—a condition which could hardly be met without making the die with lugs on the end of the prongs for a clamp ring, said lugs to be ground off after the die was finished.

The principal troubles encountered in the manufacture of these dies are due to improper handling of the die in hardening and are three in number, as follows: First, imperfect lead, due to unequal lengthening or shortening of the prongs which, with poor steel, is sometimes so bad as to spoil the dies; second, springing out of the prongs in a curve so that when closed down to size the die cuts a taper thread the length of the thread in the die, making it impossible to thread up near a shoulder; third, twisting of the prongs so that when closed down the contact with the piece to be threaded is not on the cutting edge of the teeth, but is back of it, causing a drag which always makes a rough thread and sometimes breaks off the screws.

The first trouble is not much to be feared where good steel is used and the proper temperature is obtained in hardening. The second and third are caused by the way the die is heated and dipped, in connection with the peculiar shape of the back end of the prong where the milling cut leaves off, as shown in Fig. 1. The die should never be heated back of the line *a b* where the curve begins, and need not be hot enough to harden back of line *c d* at the end of the teeth. If this is strictly adhered to the die will come out practically straight, while on the other hand if the die is hardened up into the curve it will always spring badly and even when it is properly dipped, if it is heated too far up, the hardening will run up far enough to cause trouble. Figs. 2 and 3 show the effect of improper hardening.

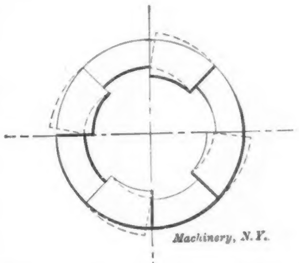


Fig. 3. Effect of Improper Hardening of Spring Screw Threading Dies.

Mr. Oberg's tables are good as far as they go, but it often happens that users of dies wish to use other outside diameters for special reasons. In such cases the following proportions will be found to work well:

The length should be 2½ times the outside diameter, the flute 3/5 of the length, and the finishing hob oversize in the proportion of 0.01 inch for every inch of the outside diameter. The flutes should be cut with a 60-degree mill for a three-fluted, or a 45-degree mill for a four-fluted die, and should be cut clear through, as the tie left by not cutting through is of no value if the die is properly hardened; it is also hard to grind out without drawing the temper. No machinist would try to turn iron or steel in a lathe with a tool

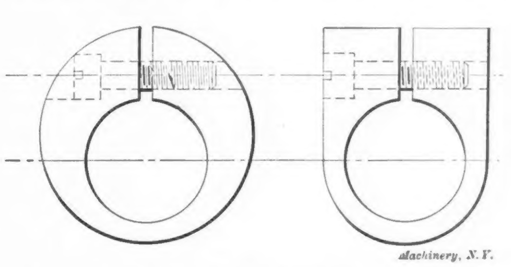


Fig. 4. Clamp Collars for Spring Screw Threading Dies.

having no top rake and, on the same principle, for wrought iron and steel, the cutting edge of the die should *always* be milled ahead of the center in the proportion of 1/64 for every ¼ inch of the diameter of the thread. For rod, brass and other similar material of a low tensile strength, more satisfactory results may be obtained by fluting the dies on the center.

The taper closing ring is a hobby with some operators, but has the objection that when used on automatics the amount of drive necessary to close the die is not sufficient to hold it from throwing the ring off when indexing, and it is nothing uncommon to see it tied back with a piece of string, cramping the die out of shape. In Fig. 4 are shown two forms of clamp collars which work well and which are superior to the one most commonly used. E. A. JOHNSON.

Hartford, Conn.

* * *

First class office buildings in lower New York cost about 40 cents per cubic foot and rent for $1 to $1.20 per square foot yearly.

A POWERFUL HOMEMADE SLOTTER.

Several years ago McIntosh, Seymour & Co., Auburn, N. Y., felt the need for a vertical planer or slotter of large capacity to be used on the large vertical and horizontal engine work which they are engaged in. Not finding the kind of tool on the market that they required they resolved to build it, and the result is a very creditable home-made tool containing a number of interesting features. The machine has fulfilled all expectations and is a powerful tool in action. It is particularly well adapted to facing off the ends of vertical engine frames or columns, the floor plate in front having ample capacity for the largest sizes yet built by the company, and this means 7,500 H. P. The general appearance of the tool is shown in Figs. 1 and 3, Fig. 1 showing it at work on the flanges of a large vertical engine cylinder. The line drawings, Figs. 2, 4 and 5, together with the following dimensions will give a fair idea of the design and construction.

The cross-rail carrying the two tool saddles is operated by a screw 4½ inches diameter, ½ inch pitch, triple thread, giving 1½ inch lead. The nominal stroke is 10 feet and the length of the cross-rail is 10 feet 1 inch. The feed of either head or saddle on the cross-rail is 7 feet, and each head has independent cross power feed. The screw nut is 16 inches long and is made of babbitt in halves. These halves are forced into a cast-iron sleeve and keyed in place. This construction has always worked very satisfactorily, giving no trouble whatever.

The screw thrust is taken on a double roller thrust bearing. The rolls are cylindrical instead of conical shape, which would be called for to make them theoretically correct, but they have never given any trouble although the speed of the screw on the reverse runs up to 450 revolutions per minute. The bearing is designed for a tool thrust of 20,000 pounds, and the actual thrust of the screw due to the inertia of the moving parts at the beginning of every reverse stroke amounts to more than 25,000 pounds. The vertical movement of the cross-rail is reversed by tappets similar to an ordinary planer, these being arranged to actuate the belt shifter by means of which the actuating screw is reversed. These tappets are counterbalanced and their position can be altered quickly by means of two cranks at the floor and geared to

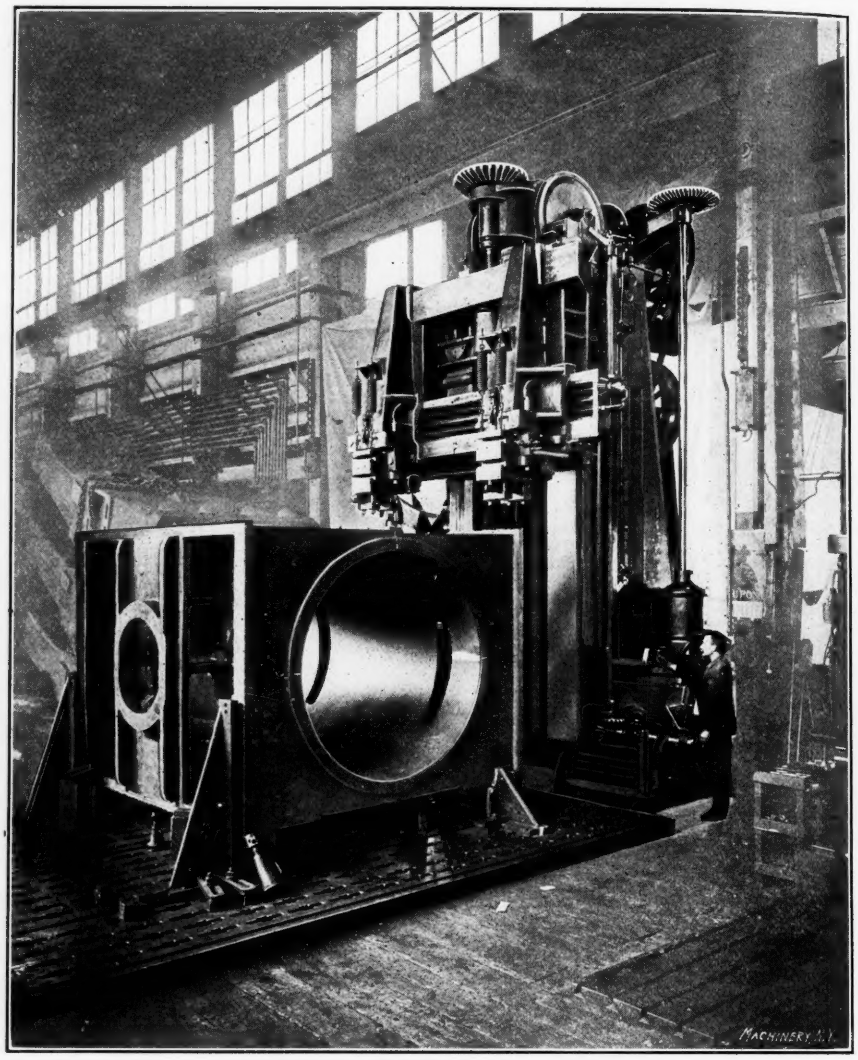


Fig. 1. Slotter at Work on Cylinder Casting.

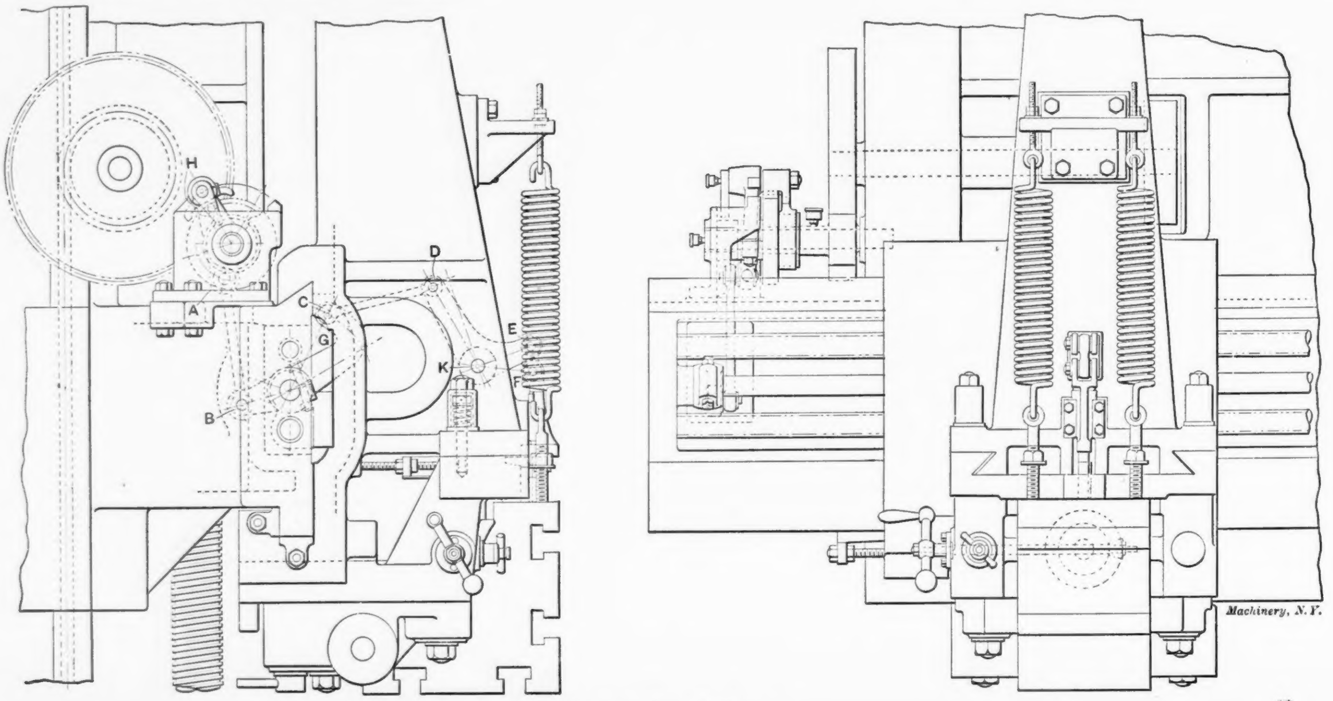


Fig. 2. Saddle of Slotter.

the tappet shifting screws so that a quick and convenient adjustment of both ends of the stroke can be made while the machine is running. This tappet shifting mechanism will be noticed in the side view of Fig. 5. The carriage carrying the cross-rail is counterbalanced. The counterbalance weighs 23,000 pounds and is situated inside the column, being carried by wire ropes running over sheaves. It was found that the inertia of the counterbalance at reversing amounted to more than its weight and it was necessary to increase the number of ropes carrying the counterbalance sufficiently to allow for this in order to secure freedom from breaking the ropes.

The column has a forward and backward feed of about four feet and in addition to the regular power feed it has a rapid power feed for bringing the machine up to the work, this feed carrying with the column all the operating mechanism, including the motor. The column feed and both saddle cross feeds can be operated from either side of the machine by hand, using stationary ratchet levers at the floor. The saddle feeds can also be operated by hand ratchets situated on the cross-rail near the work. In addition to these feeds a short movement of about 4 inches is provided in the tool-heads for advancing the tools to the work. The details of this are included in the view of the saddle, Fig. 2. Fig. 2 shows a relief gear for clearing the tool on the return stroke which does not now appear in the machine for the reason that it was discarded after being built, it having been broken by feeding the saddle too far out on the cross-rail and considerable change of design being necessary to avoid recurrence of the accident.

The machine is driven by a 25 H. P. General Electric motor arranged so that speeds can be ranged from 550 to 750 revolutions per minute, these speeds giving a cutting speed of from 12 to 20 feet with a return speed geared 3 to 1. The machine will work with cuts from 1¼ to 1¾ inch on both tools with feeds up to ¼ inch without showing any weakness or trembling; feeds over 1-10 inch are not desirable, however, on account of the tendency of the tool to break out the casting at the end cut. Its weight is 222,000 pounds.

* * *

CASEHARDENING WROUGHT IRON.*

Wrought iron is nearly pure decarbonized iron and is not possessed of the property of hardening. Articles made from wrought iron may be externally converted into steel without depriving the interior of its natural character of structure. The process is called "casehardening."

The object of casehardening is to obtain an external steel encasement with a core of fibrous iron in the center. The effect is produced in a perfectly air-tight box with animal carbonizing matter. The box should be made of plate or cast iron from ½ to 1 inch thick, the size and thickness of the box depending on the articles to be operated upon. The articles are put in the box in alternate layers with the carbonizing ingredients, commencing at the bottom of the box say with a layer of granulated bone 1 inch thick; upon this a layer of the articles is placed, then another layer of bone about ¾ inch in thickness, and so on until the box is nearly filled, finishing with a layer of bone on top of the articles, which should be 1 inch deep so as to well protect the first or top layer of articles and prevent blistering. The packing completed, the lid is put on and hermetically sealed or luted with loam or fire-clay.

The box or boxes are now placed in a suitable furnace. The furnace should give a uniform heat of about 1350 degrees F. Overheating is injurious, and will crystallize or make the articles brittle. In heating wrought iron for casehardening there are several considerations, the principle ones being heat and duration of time for carbonization, same being governed by the size or bulk of the work to be casehardened.

Heating in point of importance stands first, for if the primary cause of bad casehardening could be traced, its origin in a majority of cases would be found in bad heating. There is no operation connected with casehardening which requires more watchfulness and gives more anxiety than proper heating. It may therefore repay us to examine with care the conditions to be observed in obtaining results. The heat must be constant and uniform and should never exceed 1350 degrees F., for the degree of heat will have a bearing on the fibrous structure of the material. A high and excessive heat will render the material brittle and if the article is light in structure it is apt to break easily in service; therefore, it behooves us not to overheat or unevenly heat articles to be casehardened. Consequently keep the furnace at a regular or constant temperature, for if the articles to be casehardened are overheated the damage is done in so far as a fibrous structure is concerned; the article is hard but the interior is brittle and crystalline when it should be fibrous and showing a dark or black appearance of its natural structure with a fine grained surface analogous to tool steel.

Where I am employed we do a great deal of casehardening, all of which is done under my supervision and direction. We caseharden as high as five tons of wrought material in 24

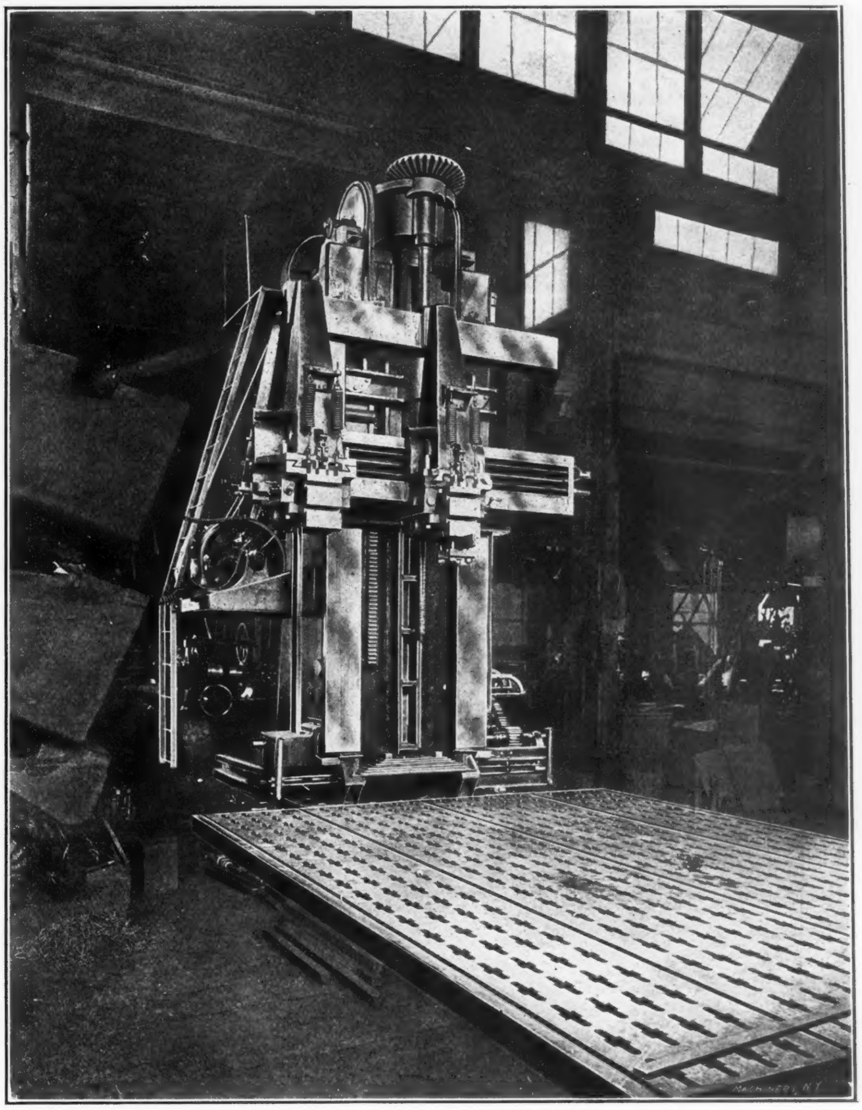


Fig. 3. General View of Slotter and Floor Plate.

* Abstract from a paper read by Mr. George F. Hinkens before the International Railroad Blacksmiths' Association Convention, Chicago, Ill., August 21-23, 1906.

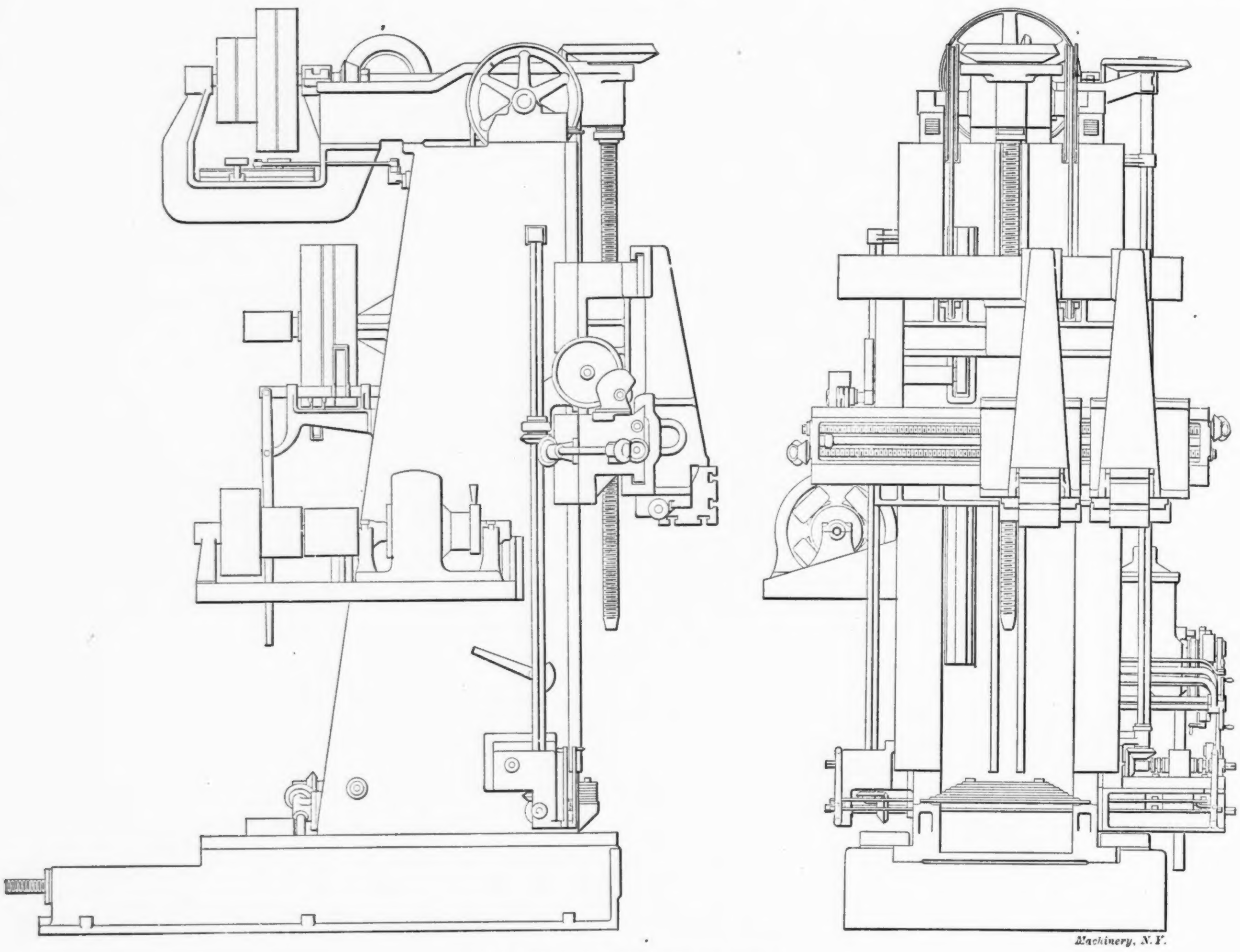


Fig. 4. Front and Side View of Slotter.

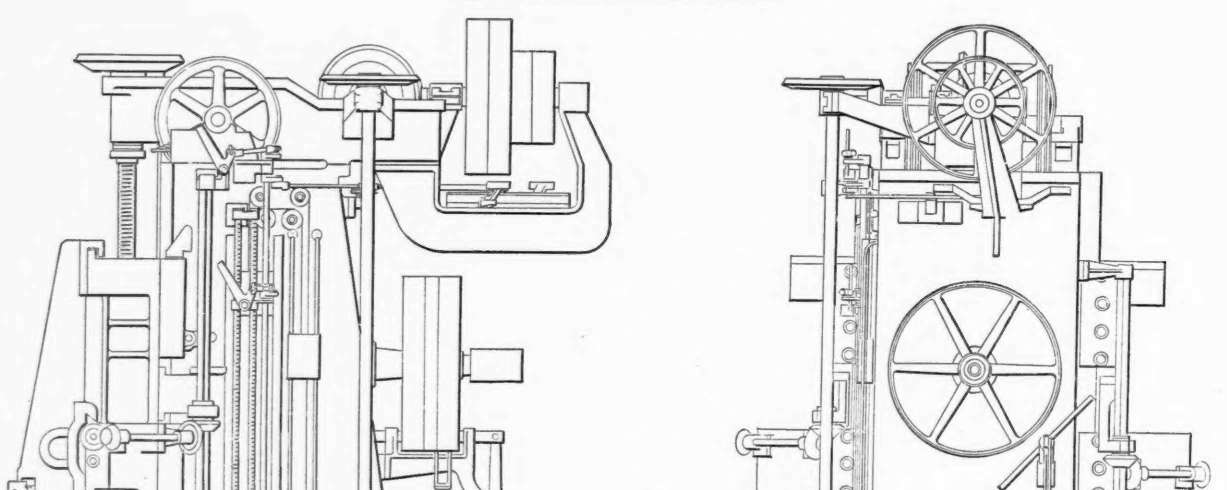


Fig. 5. Side and Rear View of Slotter.

hours, same requiring ten furnaces. We are exceedingly particular about the heat treatment, as much so as we are in the heat treatment of tool steel when tempering.

The furnace is an important factor. An oil or gas furnace to work successfully should be so constructed as to secure proper mixture of gases, a thorough and even combustion in every part of the furnace. The furnace should be constructed with roof arched throughout its entire length in order that the heat may be reflected directly and uniformly upon the boxes. The passage to the chimney is formed underneath the hearth, causing a down draft, the action being to throw the heat down upon the boxes. There are six flues, separated from each other at the end farthest from the fire place. These flues run parallel toward the fireplace or cumbustion chamber where they are connected downward with the main flue under ground, thence into the chimney.

It will be seen that this arrangement of furnace insures as nearly as possible an even heat throughout every square inch of heating parts of furnace. The furnace thus described can be heated with either oil or gas and has a capacity of eight boxes 12 inches wide, 20 inches long, and 8 inches high. The size of the box is of course governed by the size of the articles to be casehardened.

A quick method for casehardening consists in heating the material to be hardened to a red heat and submerging in a bath of molten cyanide of potash or potassium, leaving it in from one to five hours, according to bulk of material to be hardened. Cyanide of potassium gives off poisonous fumes, consequently the vessel containing it should be placed in a furnace with a draft. This method is dangerous for the operators and should, if used at all, be used in a very careful manner.

* * *

AN EXPOSITION OF SAFETY DEVICES.

The American Institute of Social Service will hold in New York City, in January next, an exposition of devices for safeguarding the lives and limbs of working men and women, and for preventing accidents under the ordinary conditions of life and labor to which the general public is exposed. This will be the first Exposition of the kind in this country, and it is surprising to note how far behind other nations we are in this respect. As far back as 1889 there was a German exposition for the prevention of accidents. In 1893 an exposition of this nature was held in Amsterdam, and since then there have been several similar expositions in continental Europe and in Canada. As an outgrowth of these national movements there have been organized several Museums of Security; one at Vienna in 1890, one at Amsterdam in 1893, one at Munich in 1900, one at Berlin in 1901, and one at Paris in 1905, and Russia, which we are inclined to look upon as semi-barbarous, has recently established a museum on a large scale in Moscow.

That these expositions and museums have been of real value to their respective countries is evinced by a comparative study of the number of accidents in Europe and in America, which shows that for the same number of men employed in a given trade, we have from two to nine times as many accidents as they have in European countries. It is estimated that the casualties of our industrial army in the United States are at least fifty per cent greater every year than the total number of killed and wounded during the late Russo-Japanese war. Such conditions can exist only through general ignorance of their reality, and it is for the purpose of educating the public to an appreciation of the actual situation and the means of its improvement that the Exposition of Safety Devices is to be held.

The interest of manufacturers generally is solicited, as well as that of organizations whose special function is to improve the conditions of labor, and a widespread response is looked for to this request for representation in the nature of photographs, descriptive drawings, models, and as far as possible, the devices themselves in actual operation. Following are some of the groups of exhibits:

Section 1.—Models, photographs and drawings of scaffolding, as well as the personal equipment of workers in building trades. 2. Protective devices for boilers, water gages, signal apparatus, boiler and pipe valves; also protective devices for electrical machinery and acetylene apparatus. 3. Protective devices for motors and power transmitters, devices for turning on power and shutting it off, belt connection, couplings, etc. 4. Fire protection and the prevention of explosions. 5. First aid to the injured. 6. Mining and quarrying; devices in use on stone crushing machinery, etc. Storing of explosives. 7. Metal industry; safety devices for metalworking machinery. 8. Textile industry: safety devices for looms, carding, etc. 9. Leather and paper industry: safety devices for paper cutting, stamping and moulding machinery. 10. Safety appliances for elevators and hoisting apparatus models. 11. Food products: safety appliances for kneading machines, rollers and cutters. 12. Personal equipment of workingmen: protective spectacles, respirators, suits, etc. 13. Workingmen's dwellings. 14 and 15. Housing: models, plans, photographs. 16. Ventilation. 17. Models, photographs and plans of toilets, dressing and living rooms, baths, etc. 18. Cooking: demonstration in heating food; models, plans, photographs. 19. Other social betterment institutions; reports of labor departments, industrial arbitration courts. 20. Agricultural machinery; safety appliances on same, demonstrated by models and views. 21. Lumber industry: safety devices for band and circular saws, planing machinery, etc., demonstrated by models. 22. Models, photographs and plans of workingmen's industrial betterment institutions of all kinds.

Requests for information regarding space should be made to Dr. William H. Tolman, Director, 287 Fourth Avenue, New York.

* * *

The remarkable extent to which the use of electricity for power purposes has been developed in the industrial plants of the country will be nowhere better exemplified than in the proposed electrical equipment of the new Gary, Indiana, plant, plans for the building of which were recently announced by the United States Steel Corporation. When completed, it is estimated that the plant will handle substantially 5,000,000 tons of ore a year, and produce annually approximately 2,500,000 tons of steel. There will be sixteen blast furnaces, of 450 tons daily capacity each, and eighty-four 60-ton basic open-hearth furnaces. The necessary electrical generating equipment capable of handling such an output is to have an initial capacity of 18,000 K.W., and will be so designed that extensions may be added indefinitely at one or both ends. The initial equipment will have a capacity of 18,000 K.W., 14,000 K.W. being in 2,000-K.W., 25-cycle, 2,300-volt units, and 4,000 K.W. in 2,000-K.W., 250-volt direct-current units. These generators will be built by the Allis-Chalmers Company, Milwaukee, and they will be direct coupled to nine Allis-Chalmers horizontal twin tandem gas engines. The power house building for the present is to be approximately 700 feet long with a span in the main building of 88 feet. An 18-foot extension under the same roof through the entire length of the structure, has been planned in order to provide the necessary room for high-tension switches. The power house will be located immediately adjacent to the blast furnace blowing engine houses, and between the blast furnaces and the open-hearth furnaces, most advantageously placed for fuel supply and for securing a minimum length of transmission lines to the various departments using electric power.

* * *

New York City, already noted for its skyscrapers, is to have another which will overtop them all and be the highest structure in America. It is the Singer Building at the corner of Liberty St. and Broadway. This building will consist of a fourteen-story building, and a tower 65 feet square and 612 feet high, containing forty-one floors, twenty-seven being above the level of the main structure. The total floor space of the building will be about 9½ acres and it is estimated that when fully occupied it will accommodate about 6,000 people. The height of the tower will be 57 feet greater than that of the Washington Monument and will be not far from two times the height of the main part of the Park Row Building, now the highest office building in the world.

* * *

When starting a nut a partial turn backwards will usually give notice when the thread of the screw and of the nut are at the right point for engagement.

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MACHINERY

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

OCTOBER, 1906.

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MACHINERY is published in four editions. The practical work of the shop, is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

American manufacturers who have received inquiries from the firm of A. Baldini & Co., Pontedera, Italy, are requested to communicate with this office.

* * *

SIMPLIFIED SPELLING.

With characteristic impetuosity President Roosevelt has precipitated a sensation in the publishing world by indorsing the so-called Carnegie simplified spelling; an order was sent to the Public Printer directing that hereafter all messages from the president and all other documents from the White House shall be printed in accordance with the rules of spelling adopted by the Spelling Reform Committee, headed by Mr. Brander Matthews, Professor of English in Columbia University. The simplified list comprises 300 words. One of the most radical changes is the use of a suffix "t," for "ed" in certain words, as for example, "addresst," "blusht," "crost," "fixt." "Through," "though," "thorough" are spelled "thru," "tho," "thoro," and so on.

The attitude of MACHINERY towards spelling "reform" will be conservative; such words that seem naturally to have arrived at the state where silent and useless letters can be eliminated, will be spelled in the simplified form, but we shall not swallow the dose prescribed at the present time by any means. Rome was not built in a day; neither has English spelling reached its present status by one leap. Evolution in language, either written or spoken, is just as real as in any other living thing. It takes place slowly, consistently with the growth of ideas and changing conditions. Hastening spelling reform by decree is something like helping a chicken out of the shell; this as every amateur poultry raiser knows to his sorrow, is not conductive to the general well-being of the chicken. Left to its own way the change comes in a natural manner without injury, but time is necessary. So we believe it is with spelling reform—or better, evolution.

* * *

REGARDING THE WASTE BASKET.

Occasionally we receive a contribution from some good-natured correspondent who adds a postscript saying that should his communication be considered unavailable, to simply consign it to the waste basket. Now, this is just one thing that we dare not do. Through somewhat bitter experience we have learned that it is quite unsafe to throw away any communication, no matter how apparently trivial it may be, unless some permanent record is made of it. Oftentimes a communication serves as the means of fixing a date for an entirely unrelated subject, etc. We are struck with wonder at the loose methods of some concerns which follow the practice of answering a communication by writing on the back. It may be a good lazy man's method, but it leaves the concern in the position of having absolutely no record whatever of its correspondence, and is a practice which, it seems to us, no concern or individual can safely follow. The old housewife's rule, "keep a thing for seven years and you will find use for it," is one that certainly can be safely followed in the office in regard to correspondence and written communications of all kinds, with the additional stipulation that after being kept seven years it shall be put in some place not entirely inaccessible and kept another seven years.

* * *

YOUNG STUDENTS AND OLDER ONES.

Without any definite information to guide us, we might risk the estimate that fully 75 per cent of the readers of the Shop Edition of MACHINERY are under twenty-eight years of age; the proportion for the Engineering Edition would probably be somewhat smaller. It is the experience of most men that, as they grow older, they find less and less time or inclination for studying the literature of the business by which they make their living. This condition is not in any sense uncomplimentary to the older men. It is due to the natural laws which have decreed that youth shall be especially the period of assimilation. When the boy first enters on his life work, he has the whole unknown field before him, and almost every principle and process of which he learns or hears, brings with it the freshness of novelty, where an older man sees only the redressing of a familiar idea in a new garb. Besides this, the work of the beginner is usually such that his mind is quite free to busy itself in the acquisition of knowledge, while the demands upon the more mature man are so great that the utmost extent of his waking hours seems insufficient for the working out of the problems with which he has to do.

No one engaged in mechanical work should feel satisfied, however, until he has learned how to apply himself to the acquisition of new knowledge, nor should he ever cease to keep himself informed of the latest developments in the field to which he has devoted his life. If he has surely formed the habit of study, it is no longer necessary that he should minutely analyze every new process or principle of which he hears; but a little while each week or month spent with the periodical literature of his business will give him an opportunity to make note, mental or otherwise, of the things concerning which he should be informed, and put him in a position to thoroughly investigate any subject that may concern him in the future.

A man who is now the general manager of a great rapid transit system, who draws what is probably the largest salary ever paid in such a position, offers an excellent example of the advantages of acquiring the habit of study, and keeping informed of contemporary developments. By dint of close application, he had made his way from a menial position to a place as master mechanic of a steam operated elevated railway, which he managed with conspicuous success. It became evident to the directors of the road in the course of time, however, that it would soon be necessary to change the motive power from steam to electricity. With this change, the previous experience and knowledge of the master mechanic would be largely valueless, and his hold on his position would become very insecure. That official, however, doubtless much to the surprise of his superiors, turned out to be an authority on the subject of electrical traction. Keeping in touch with contemporary progress in his field, he had scented the coming change from afar, and had employed his time to such good purpose that he was able to convince them that he was competent to plan and superintend the proposed improvements. In a word he "made good" in his old position with the new motive power, and was shortly afterward called to the high place he now occupies. It would be hard to find a better example of the proper attitude for the mechanic or engineer to assume toward the changing conditions of his business as he grows older.

GERMAN MACHINE TOOL COMPETITION.

The enormous increase of German machine tool manufacture should not be underestimated by American machine tool builders. The fact that the Germans do not appear as actual competitors in this country on account of our protective tariff does not exclude the inference that they will be, and already are, the most resourceful of all our competitors in the foreign market. The export of German machine tools in 1905 was more than three times as great as in 1900. The import of American machine tools to Germany had during the same period decreased so that in 1904 the import was less than half, and in 1905 about 30 per cent less than the import in 1900. The decreased imports are so much more significant when considering that the German tariff on machine tools is very low, amounting to only five, or at most ten per cent *ad valorem*.

At a recent meeting of German machine tool builders in Dusseldorf the confidence in their increased prestige was plainly in evidence. While recognizing that only a few years back there existed an "American Danger" to the German machine tool industry, it was agreed upon that this danger was now a thing of the past, provided that the German manufacturers continued to follow the path outlined by their successful American competitors.

While there is no doubt but what American machine tool builders will manage to remain in the lead, it may be well to point out the progress made in Germany. There is one distinctive feature about all German machine tools which cannot be overlooked. They all prove that there was a definite knowledge of mechanical principles involved in their design. The ingenuity with which some problems have been solved is surprising, and the only serious objection to a great majority of German makes of machine tools is the lack of recognition of the requirements of the operator. Some, indeed, require far more skill to operate than can be expected of an ordinary machine hand, while others are often to the highest degree "unhandy" to run. To remove these obstacles will probably be the next move of our German brethren, and then their competition may be so keenly felt that we will commence to discard the "cheap labor" which has of late been complained of as taking possession of our drafting rooms, and once more return to the maxim that practical experience without knowledge of mechanical principles is equally inefficient as is theoretical knowledge void of practical common sense.

* * *

WILL THE AUTOMOBILE FOLLOW THE BICYCLE?

The rise and decline of the bicycle was a phenomenon well within the memory of most readers. The building of bicycles and tricycles began in England and the first machines imported into this country attracted much attention. The writer remembers one aged townsman who bought an English tricycle at a cost of $250. Its advent in the town (about twenty-five years ago) was a nine-days' wonder and it was considered of sufficient interest and novelty to warrant giving it a place of honor in the principal exhibition hall of the county fair. The owner had the right of way on the sidewalk of the town, where he could often be seen gravely propelling himself on sunny afternoons, kindling envy in the hearts of small and large boys alike. He had a wide plank walk laid at considerable expense around his large garden, where in dignified retirement he could take exercise runs without the annoyance of being so much on public exhibition. Within a few years after, bicycles were owned by thousands, and every city, town and hamlet had its quota. Century runs were the thing and holidays and Sundays were given up to bicycle riding by a large part of the population. To-day it might almost be said that the bicycle is again something of a curiosity. In many towns it is rarely seen on the streets and is mostly used by messenger boys and others in business. In short, its use for pleasure has been very largely abandoned.

The automobile has, in a sense, displaced the bicycle, and in view of the experience of the bicycle many are asking themselves if the same waxing and waning of popularity will not be its fate. It seems somewhat improbable that as a vehicle for mere pleasure it can long continue to have the great vogue that it now enjoys. The first cost of the higher powered machines and the succeeding expenses put them out of the reach of most men; many who are now enjoying an automobile have discounted the future in order to do so. The memory of the bicycle century runs is recalled on seeing an automobilist tearing through the country at railroad speed, going nowhere in particular and seeing nothing as he goes. This is to say the least unprofitable, and anything which yields no profit and little pleasure is bound to be ephemeral in its popularity. We have always believed that the larger use of the automobile is, or should be, as a commercial vehicle for handling goods that are now largely drawn on trucks, and for the general sober business of the day. Unless it can make good for such purposes we may see the automobile become one of the "has beens" in comparatively few years.

* * *

THE FLAT ON THE TOP OF SHARP V-THREADS.

While theoretically the sharp V-thread is not flatted on the top of the thread, it has, on account of practical reasons, become necessary to provide this kind of thread with a slightly flatted portion. In the first place, it is very difficult to produce a perfectly sharp edge on the top of the thread, and, in the case of a tap, the sharp edge would be very likely to be impaired in hardening, leaving the top of the thread less perfect than if provided with a slight, uniform flat. In the second place, the sharp edge would wear away very rapidly, both in the case of a tap and a screw, and as the wear could not be expected to be uniform, the ultimate result would be far less desirable than the one obtained by slightly flatting the top of the thread from the beginning.

For the reasons mentioned it has always been the practice of tap manufacturers to provide the top of the thread on V-thread taps with a slight flat. But as a standard outside diameter always had to be maintained, the diameter in the angle of the thread had to be increased. This has caused difficulties, inasmuch as there has been no established standard as to *how much* of a flat the thread ought to be provided with, and various manufacturers have each had their own practice in this particular. The result has been that the gages from one firm have not corresponded to the taps manufactured by another, and many customers, not familiar with the reasons for this confusion, have questioned the correct size of gages as well as taps. The question has been still more confusing on account of the fact that many manufacturers did not have even a certain standard for all taps manufactured by them, but working to their old-established gages, they often produced large taps with smaller flats on the top of the thread, proportionally, than the flats on smaller taps.

In order to overcome the difficulties arising from the facts mentioned, we understand that the tap manufacturers are endeavoring to establish a standard flat for the top of sharp V-threads. While, as far as we know, nothing has been definitely agreed upon as yet, there seem to be opinions favoring a flat equal to one-fifteenth of the pitch. This is a greater flat than has hitherto been employed by some leading tap makers. Some have used the same flat for the V-thread as is used for the Brigg's standard pipe tap thread, which, although theoretically rounded at top and bottom, is, in this country at least, made with a small flat on the top of the thread. The width of this flat is selected so as to give exactly the same angle diameter as is obtained when rounding the top of the thread in accordance with Brigg's original proposition. This flat is equal to about one-twenty-fifth of the pitch.

While the exact width of the flat is of minor importance, it will save much confusion, as well to manufacturers as to customers, if a standard is agreed upon, and the country is to be congratulated upon the fact that there is a strong movement toward adopting standards in all the different fields of industrial activity.

* * *

The report of the United States Geological Survey gives the production of Portland cement for the year 1905 as 35,246,812 barrels, having a value of $33,245,867. This represents an increase of nearly 25 per cent over the output of 1904.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The extent to which industrial education is carried in Germany is most easily comprehended when we hear that the number of students at the ten higher institutions for technical education was 15,800 during the winter term of 1905-1906. As there is a still greater number of smaller colleges and trade schools, all of which are attended by large bodies of students, it is no wonder that at present men of good technical education have to accept very inferior positions as far as salary concerns; but the excellent system of technical and industrial education in vogue in Germany has undoubtedly been the most active cause in the present progress of the industries of that country.

Regarding the sale of machine tools in China, Consul-General William Martin, of Hankow, China, says that it is a waste of money to send catalogues to China in English, and, in fact, intimates that the use there of catalogues in any language is a waste of time and money. The Chinese will not buy that way; their purchases must be made from the man on the ground who has the goods to show. They are very suspicious and take nothing on faith. The Germans now have many men laying foundations in China for future trade, and the Japanese as well as the British are very active. The consul believes that China will eventually be a great field for the sale of foreign tools and manufactured goods of all kinds.

A writer in a textbook on standard metals for manual training schools says: "Copper is seldom used in the form of a casting for the reason that it has no special merit in any heavy form, but when combined with other metals its greater merit is apparent." This statement is not altogether exact. One very potent reason why copper is seldom used in the form of a casting is the difficulty of making pure copper castings free from blowholes. Molten copper has such an affinity for oxygen that its exposure to the air even during the short period of pouring into a mold is sufficient oftentimes to make the castings porous, and unless the molder is unusually expert, the chances are that his efforts to produce sound copper castings will be without avail.

According to *The Canadian Engineer*, the two electric locomotives which have been used to haul the trains through the Simplon tunnel have proved inadequate for the work. Each of these engines had two motors of 450 horse power, which could be urged up to 550 horse power. As to the cause for the failure of the engines there are two theories. One is that the engines, having a section of two-thirds of the sectional area of the tunnel itself, acted as pistons in a cylinder, and wasted a large portion of their power in compressing the air in front of them. Another theory is that the air, saturated with the moisture from hot springs which keep the tunnel walls at a temperature of 93 degrees, penetrated the insulation of the motors and caused an important leakage of the current.

We have received a reprint of an article, "The Submarine vs. The Submersible," by Mr. Simon Lake, published in the *Journal of the American Society of Naval Engineers*, May, 1906. This paper treates in an interesting manner of the relative stability of the submarine and submersible boats that have been built for naval purposes. It points out the weakness of the submarine type which depends upon angular change of the horizontal axis in order to rise or descend. Comparison with the submersible or Lake type is, of course, favorable to the latter, the reasons given being well worth reading. In fact the whole article is well worth reading by any one interested in the subject from a military standpoint, or for a study of the actions of bodies immersed in a liquid and dependent upon that liquid as a resisting medium for all movements.

The German government, always ready for experiments, has undertaken to ascertain the comparative value of a typewritten copy for legal documents as compared with a handwritten one. The object of the experiment was to find whether a typewritten document would stand the test of time equally well with one written with the best writing ink. It was found that a decided difference could be noticed according to what class of ribbons were used for the typewriter, but it was ascertained beyond doubt that by using the best ribbon obtainable a copy could be produced which would have the same lasting qualities as a handwritten one. It is of interest to note that while some German ribbons proved satisfactory, the American-made product proved to be of a higher quality in general. But we may be assured that the Germans will not rest from now on until their typewriter ribbons are prepared equally well with ours.

One of the most progressive of the independent principalities of Asia is the little kingdom of Siam on the Indo-Chinese Peninsula. In the principal city, Bankok, is a modern electric railway power plant, operated by the Siam Electricity Company, and equipped with reciprocating engines and generators. Because of the increased demand for power an additional unit has become necessary and a Curtis steam turbine has been ordered. This is a 500-kilowatt, 575-volt machine, built by the General Electric Company, Schenectady, N. Y. The boiler plant for this station is unique in that paddy husks are burned in place of coal. The fuel is brought down the river from the rice fields in flat-bottomed boats to the power house and unloaded directly into the boiler room by an elevator and belt conveyor, built by the Link Belt Company, Philadelphia, Pa., and operated by several direct-current motors. This method of using rice husks for fuel is an economic utilization of a waste product similar to the use of the crushed sugar cane, or bagasse, on sugar plantation in Cuba and other countries.

Consul Wm. Bardel writes from Bamberg that Engineer Balderauer, of Salzburg, has invented a balloon railroad, experiments with which are now being made in the mountains in the neighborhood of that German city. It consists of a captive balloon, which is fastened to a slide running along a single steel rail. The rail is fastened to the side of a steep mountain, which ordinary railroads could not climb, except through deep cuts and tunnels. The balloon is to float about 35 feet over the ground, and a heavy steel cable connects it with the rail. The conductor can, at will, make the balloon slide up and down the side of the mountain. For going up the motive power is furnished by hydrogen gas, while the descent is caused by loading up with water, which is poured into a tank at the upper end of the trip, and thus serves as ballast. Suspended from the balloon is a circular car with room for ten passengers. The cable goes from the bottom of the balloon through the center of the car to a regulator of speed, which is controlled by the conductor. The inventor of this railroad claims that his patent will force all incline cable roads out of existence. Of course!

The subject of denatured alcohol takes up a considerable part of consular report No. 2,662, it being devoted to the production, manufacture, distribution and consumption in Germany and France. The consumption in Germany of completely and partially denatured alcohol has increased from 25,429,118 gallons in 1901 to 36,943,869 gallons in 1905. Methods of denaturing and the ingredients used are referred to at some length. In France, the government has made considerable effort to stimulate and extend the production and use of alcohol for industrial purposes, but the results have not been altogether satisfactory. The ministers of commerce and agriculture organized a special exhibition and offered prizes for the most effective type of alcohol motors, both stationary and portable, for motor vehicles, alcohol lamps, stoves, etc. The result of this exhibition has been on the whole disappointing, the consumption for such purposes not having increased to

any important degree. It is claimed that the French motor car builders have not found alcohol fully successful, the vapor exploding more suddenly and powerfully than petroleum vapor, and the gases attack bright iron and steel so that it is somewhat difficult to keep cylinders, valves and pistons in order. A mixture of 20 to 30 per cent of benzine gives somewhat better results, but is open to the objection that alcohol and benzine do not volatilize at the same temperature, hence one ingredient of the mixture will be exhausted more rapidly than the other.

The technical schools have filled a want, and have done much good in certain branches of industry, but they assume too much when they undertake to give a young man a course in conservation of forces, statics and dynamics, graphic statics, strength of materials, mechanics, drawing, machine design, mechanical engineering and shop practice, all in the short space of four years. He is given a diploma, signifying he has nothing more to learn and is capable of taking the management of a factory. I had a young man as draftsman, who had taken an engineering course in one of the Boston technical schools. He carried a sample of work with him which he had made during his course in shop practice. It consisted of two pieces of cast iron about two inches square and one inch thick. One piece had a groove about three-eighths of an inch square cut across the face, the other piece had a corresponding projection across its face, together forming a tongue and groove. These pieces were accurately fitted together so that the tongue could slide from end to end and when reversed fit just as accurately. I asked the young man what tools he had to do the job with. He replied: hammer, chisel, file and scraper. I then asked him how long it had taken him to make the piece. He said that he had spoiled two or three pieces before he got them to fit, and that in all, he had probably spent three or four days upon the job. Any modern machine shop could duplicate those pieces with profit for 15 cents or 20 cents apiece. *Time and cost* are the main functions in productive science, and when these essential features are not included in the so-called shop practice, the true object of technology is lost.—*Extract from paper "Value of Technology" read by Mr. Thomas Hill before the Western Society Associated Engineers, July* 18, 1906.

The proposal to utilize metallic colloids for industrial and other purposes opens up at once an extraordinary field of speculation. A colloid, according to Dr. Kuzel, contains energy. "It may possibly be looked upon," to use his own words, "as a primary source of energy. The colloid condition is in fact a dynamical condition of matter, while the crystalline condition is the static condition." "One of the most striking properties of the colloidal condition," he goes on to say, "is that bodies, for instance, metals, which under ordinary conditions are not soluble in water, benzine, or benzol, etc., become at once soluble in these mediums without in any way losing the chemical nature when in colloidal from." Dr. Kuzel instances two colloidal forms of metals, one of which he calls "sols," the other "gels." The latter, according to him, have the property of gelatinizing, assuming the appearance and substance of albumen. In this form metals may be mixed together, forming any desired alloy in a soft or plastic condition. In this form, metals such as wolfram, molybdenum, uranium, tantalum, thorium, etc., may be utilized, according to the inventor, for, among other purposes, incandescent light-giving filaments; that is to say, using Dr. Kuzel's words in his English patents: "Of this plastic mass I form bodies in any known or suitable manner of the shape and size desired for the light-emitting bodies to be produced." A metal or combination of metals in gels, or colloid coagulant form, can be "squirted" in the fashion employed in making ordinary incandescent filaments, or in the manufacture of cordite. The plastic filaments thus produced are then heated to a white heat, when, according to the specification, they return to a crystalline state, "their diameter and specific resistance diminishing notably." Dr. Kuzel, it may be mentioned, has a large laboratory at his home in Austria, and has repeatedly demonstrated there his processes in colloids in a practical form.—*Times Engineering Supplement.*

THE NON-LUMINOUS ALCOHOL FLAME.

Among the points brought out in the investigation of the availability of alcohol as a fuel for the internal combustion engine is the advantage it derives from the non-luminous character of its flame. As is well known to any one who has ever seen alcohol burn, its flame is bluish and gives out little light, which means that it is almost entirely devoid of free carbon particles. It is these particles of incandescent solid matter which give to a flame the greater part of its heat radiating power. When gasoline and most other oils are burning, the flame, made luminous by carbon or soot, radiates heat to such a degree that it is not possible to approach near the conflagration and combustible surroundings are readily fired by pure radiation. Not only does this property of alcohol render the fuel a safer one in case of accidental ignition, but it has a favorable effect as well when used as a fuel in the cylinder of an engine. Since the flame has very slight radiating power less heat will be absorbed by the walls of the cylinder, and consequently much less will be taken up in the water jacket and carried away as lost heat, than is the case when gas or any form of petroleum is used.

POWER TRANSMISSION BY MEANS OF GAS.

In a paper read recently before the Society of Arts, London, on coal conservation, power transmission and smoke prevention, the author, H. A. Martin, as reported in the *Electrical Review*, suggests the possibility that gas may be found a more economical and convenient means of transmitting power over long distances than is electricity. This possibility is especially applicable to the case of London, which has no large hydraulic power near it to serve as an economical source of electricity, but has to depend instead on coal which is brought to it from the northern counties. Aside from the question of cost, the enormous volumes of smoke generated by the burning of this coal intensifies the fog which is one of the most serious problems that that city has to deal with. It is pointed out that gas could be generated from coal at the mines and transmitted under a pressure of about 500 pounds per square inch to the power centers, where it can be used for heating and in internal combustion engines. This high compression, which is the most costly and serious feature of the plan, is necessary, otherwise the cost of the large pipes which would be required for low pressure gas, would swamp the undertaking. This makes necessary a pressure reducing plant at the receiving station. Mr. Martin, to make the system as economical as possible, proposes a number of refinements by which sufficient savings may be effected to counterbalance the cost of transporting the gas, and stress is laid as well upon the by-products of the system—the production of fertilizing and other substances. The utilization of the cooling action of the expanding gases in refrigerating plants is also suggested. The plan would thus involve quite a complication of details, enough, perhaps, to render its success somewhat doubtful.

Power transmission by gas, however, it is considered, would solve some of the problems not solved up to the present time by electrical transmission. While all admit that no small motive power can compare with the electric motor, and that electric lamps are the best illuminating agents yet devised, yet when it comes to heating, the electric system is at a disadvantage. Electric heaters are perfectly effective, that is to say all the energy supplied to them is converted into heat, but the losses which have taken place before the energy reaches the heater are very great; while in the gas system all of the energy of the gas is converted into heat. In other words, we start with our energy in the form of heat which is obtained by burning the gas. In an electric system we must carry this through a number of transformations, one of which, that from heat into motion, is not very efficient. This objection applies only to electric energy generated from fuel; when obtained from other sources the transformation ratio is high and the cost depends mainly on the cost of the apparatus.

Mr. Martin suggests that the amount of coal consumed by coasting steamers, freight and switching engines, which now carry the fuel supply of London, is no inconsiderable factor in determining the most efficient means of transferring the

required energy from the mines to the metropolis. In the proposed gas pipe-line system, however, there happens to be a source of power already available in the heat of combustion from the gas producing apparatus. The gases leave the retort ovens at a very high temperature, the greater part of their heat being generally wasted, when, by means of suitably arranged boilers, they probably might be made to furnish all of the steam required to work the compressors.

SOME USES OF PURE MANGANESE AND ITS ALLOYS.

Mechanical World, August 10, 1906.

A good deal of information has recently been published regarding the uses of magnesium as a deoxidizer for obtaining sound casting of certain metals and alloys. It does not appear to be generally known that manganese can be used with even better results for most purposes; therefore, the following brief remarks are of interest:

With manganese it is necessary to use the purest metal obtainable. Manganese made by the Goldschmidt aluminothermic process has a purity of about 99 per cent, the balance being chiefly silicon; this manganese is free from carbon, and technically free from iron, a point which makes it of great benefit for special brass and other alloys.

Pure manganese is a very brittle metal, and resists atmospheric influences for an unlimited time; its fusing point is about 2,240 degrees F. Among its chief characteristics is the ease with which it alloys with copper, nickel, zinc, tin, aluminum and other metals.

Pure manganese may be added in any percentage to zinc-copper alloys, the result being a very considerable increase of strength and density, and often of elasticity; such alloys can also be more easily rolled. It should not, however, be added to tin-copper alloys containing more than about 2 to 3 per cent of tin, as the quality of the material is thereby deteriorated.

For nickel castings, manganese is used as a deoxidizer to produce a greater density. In this case about 2 per cent is added to the molten nickel. It is also used with beneficial results for making German silver. If about ½ per cent is added a bright color is produced similar to that of silver.

For aluminum alloys an addition of manganese copper, free from iron, which is made from pure metallic manganese and electrolytic copper, is preferable to zinc or nickel additions. About 3 per cent of manganese-copper will increase the strength of the material, give denser castings, and the alloy can be more easily machined.

Copper and bronze castings lose their brittleness if manganese is added instead of phosphorus; a material is thus obtained in which threads may be easily cut. Manganese-copper alloys are made to a large extent, containing from 2 to 12 per cent of manganese. Bronzes with 5 to 6 per cent of manganese have about the same color as copper and are very fire-resisting; they are used in the fire boxes of locomotives.

Manganese fulfills two purposes. First, it is a deoxidizing agent. In general, an addition of about ¼ per cent of manganese is sufficient. Compared with other deoxidizing agents, like phosphorus, manganese has the great advantage that if a surplus quantity is added, it improves the quality of the bath (the only exception being the case of bronze rich in tin); whereas, if too much phosphorus is added, it impairs the quality of the bath. In some cases about 1 per cent of manganese is added, in conjunction with phosphorus.

Second, it improves the quality of a great many metallic alloys. It combines easily with and has a great affinity for oxygen; moreover, since manganese oxide slags are very fluid and have a low specific gravity, they easily and quickly separate out of the baths. All castings with manganese alloys are to be made under exclusion of air as far as possible. It is, therefore, useful to sprinkle a small quantity of borax upon the surface of the metallic bath in the crucible. It then forms a thick plastic slag.

Manganese alloys with tin and zinc can also easily be prepared; generally, the following proportions are used: 20 parts of manganese to 80 of zinc, free from lead; 50 parts of manganese to 50 parts of tin, free from lead. The slag formed on the molten tin and zinc must, of course, be removed before adding the manganese, and the charge is kept heated for a couple of hours. With zinc it is important to take care that the temperature remains constant and does not increase. The loss in the preparation of 20 per cent manganese-zinc is only 4 per cent.

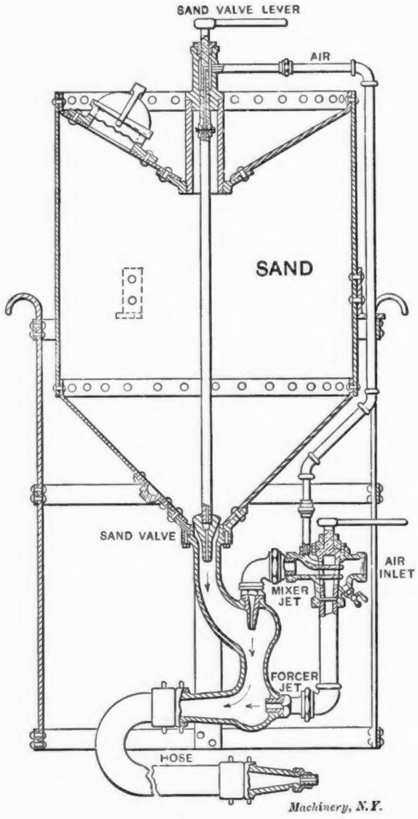
Manganese-copper free from iron is used in the nickel cupro manufacture of cartridge cases, etc., and does away with the annealing process.—W. B., Jr.

CLEANING CASTINGS BY THE SAND BLAST.

J. M. Betton, in *Compressed Air*.

This article on the sand blast and its use in cleaning castings, buildings, bridges, etc., covers practically the entire field of applicability of the sand blast for cleaning purposes, but in the following we have collected only such portions as are of service in foundry work.

In a sand blast apparatus, and especially in the injector sand blast, the injector principle is followed closely in first starting the flow of sand by creating a mild vacuum by means of a vertical jet through the sand valve, equivalent to the suction jet of the steam injector, mixing the sand and air by means of the second vertical or mixing jet, which also starts



Vertical Section through Sand Tank and Injector.

the combined current forward, and by augmenting the velocity of the current, using a horizontal or forcer jet, as well as by contracting the walls of the mixing chamber. In other words, the air supply is sub-divided and applied in such manner as to make its effort cumulative, thus producing a vigorous blast of thoroughly mixed sand and air, each grain of sand being projected upon the work with the highest possible velocity. By sub-dividing the air, the injector sand blast is able to obtain the same results with less consumption of air than the ordinary sand blast, in which the sand drops into a current of air and is blown onto the work. The general arrangement of an injector sand blast is shown in the cut, in which it will be seen that the first current of air to set the sand in motion passes in through the sand valve; the second or mixer jet enters a short distance below this, and the last or forcer jet sends the current of well-mixed air and sand into the nozzle pipe.

To obtain good results with a sand blast it is necessary to provide an ample supply of air. In the following table the

number of cubic feet cf free air per minute required under different pressures for nozzles of different sizes is given:

Diameter of Nozzle in inches.	Air Gage Pressures in Pounds. 5	10	15	20	25	30
1/4	14.4	21.8	26.7	30.8	34.5	40.
3/8	34.6	49.	60.	69.	77.	90.
1/2	61.6	87.	107.	123.	138.	161.
5/8	96.5	136.	167.	193.	216.	252.
3/4	133.	196.	240.	277.	310.	362.
7/8	189.	267.	326.	378.	422.	493.

AIR PRESSURE REQUIRED.

For light work (stove castings, etc.) .... 5 to 10 lbs.
For medium and heavy grade iron castings....... 15 to 20 lbs.
For steel castings................................ 30 to 75 lbs.
For cleaning buildings and steel structures....... 5 to 30 lbs.
(According to height.)

The proper size of air tank for ordinary foundry work is about 30 inches diameter by 6 feet long, and it should be provided with a safety valve, a pressure gage and a blow-off, the latter near the bottom to remove water condensed from the air.

It is especially desirable that the air piping from receiver to sand blast be not less in diameter than the air connection of the sand blast. If the distance between the receiver and the sand blast is more than 75 feet, the pipe should be larger than the air connection of the sand blast, to allow for loss of pressure from friction. It is not that the sand blast will take all of this air; it can only take the amount which the nozzle will discharge under the working pressure (a ½-inch nozzle under 30 pounds' pressure will take 161 cubic feet of free air), but the best and most satisfactory results are only obtained by having this backing of air behind the jets.

The air piping should be protected from condensation if the lines be long, and if moisture or water shows in the air at its entrance into the sand blast, it is necessary that some means of removing this and drying the air be provided. This can be done by an "after cooler," or by means of one or more "U" loops introduced in the line of air piping. Drip cocks at the bottom of these loops will draw off the entrained water, or it may be removed by an ordinary bucket steam trap.

Water must be kept from the sand to insure proper working of the sand blast. If it enters the tank it will cause the sand to cake and arch over the sand valve, and the only remedy is to shut down, draw off the sand and start over again with dry sand.

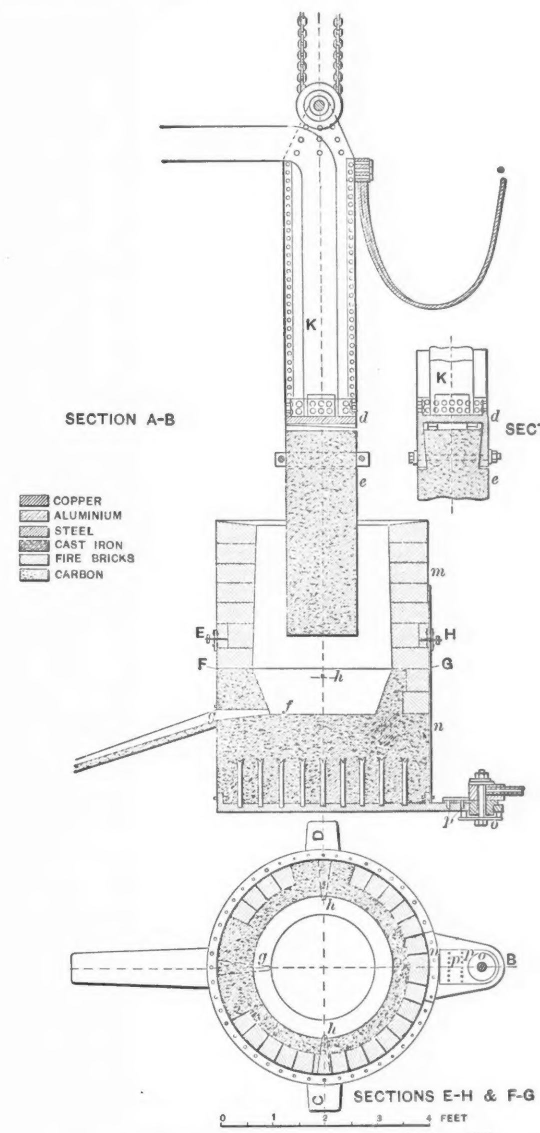
Dry sand, if left in the tank over night, will absorb moisture and may refuse to work the next day. The sand should be perfectly sharp, clean quartz or silica, sifted through a screen of proper mesh, and dried long enough beforehand to have it cold when used. If too warm it will generate steam in the tank, and if heated very hot it will crack and disintegrate. With a ¼-inch nozzle, the sand should be passed through a No. 8 mesh screen. With a ½-inch nozzle much coarser sand can be used, and the injector sand blast has been operated successfully with pebbles averaging ⅛ inch in diameter, using them again and again. These quickly rounded off their sharp edges, and their action upon the castings can be compared to that of peening them with an infinite number of small ball-peen hammers, cleaning them very thoroughly and giving a very good finish. A coarse sand or gravel will be found effective for general work in the foundry, especially for steel castings. W. B. Jr.

ELECTRIC SMELTING OF IRON ORE.

Under the auspices of the Canadian government quite a number of experiments have been made at Sault Ste. Marie, Ontario, on the smelting of iron ores by means of the electric furnace. These experiments have been conducted under the direction of Dr. Eugene Haanel, whose preliminary official report was recently made public. From the information given in this report it appears that the electrothermic process is likely to come into extensive use in the future, in the manufacture of high-grade steel and iron alloys, and possibly even in the production of pig iron.

The furnace used in the experiments is shown in vertical and horizontal sections. The dimensions of the furnace are as follows: Diameter of bottom of crucible, 2 feet; height of lower cone, 11 inches; height of upper cone, 33 inches; diameter at junction of the two cones, 32 inches, and at top of furnace 30 inches. The carbon electrode is 16 inches square and 6 feet long. The lower part of the furnace is made of carbon paste; the upper part of fire brick with a lining of carbon paste.

A 50-volt, 30-cycle transformer furnished the electrical energy. The principal ore experimented with was magnetite, and as it is to some extent a conductor of electricity, it was expected that considerable difficulty would be experienced in smelting it. It was thought that with the furnace used, as the electrode is immersed in the charge, current would leak laterally through the charge and thus prevent a sufficient amount from reaching the fusion zone to develop the high temperature required for fusion. With charcoal as a reduc-



Sections of Heroult's Electric Furnace for Iron Ore Reduction.

ing agent no such difficulty was experienced; in fact, when crushed so as to pass through a ¾-inch mesh it worked as well as coke briquetted with clay.

In one of the experiments the charge of the furnace consisted of: Ore, 400 pounds; charcoal, 125 pounds; limestone, 25 pounds; sand, 6 pounds. The data relating to this experiment is as follows:

Length of run, 65 hours 30 minutes.
Current voltage, 36.03.
Current, amperes, 4,987.
Electric horsepower, 221.34.
Ratio of weight of slag to that of iron, 0.41.
Pig iron produced, 11,989 pounds.
Pig iron per 1,000 electrical horsepower days, 9.92 tons.

An important result of the experiments was the fact that ores of high sulphur content, not containing manganese, can be made into pig iron containing only a few thousandths of a per cent of sulphur.

The ores treated, with the exception of the hematite and roasted pyrrhotite, contained a high percentage of magnesia, producing a very infusible slag. When the furnace had been running for some time this infusible material formed a scale around the crucible, the electric energy available not being sufficient to keep it in a molten condition. The crucible and lower part of the furnace were, therefore, partially filled up, preventing easy access of the charge to the reducing and melting zone. This slower feeding left the charcoal on top of the furnace exposed to the air a longer time, thus increasing the amount of charcoal required and decreasing the output. With a greater current than was available and consequent higher temperature, the formation of the scale would have been prevented, and the output correspondingly increased.

The consumption of the carbon electrode is small, as may be seen from the fact that 384 pounds were consumed in the production of 42,711 pounds of pig iron, which is at the rate of about 18 pounds per net ton of metal. The consumption of the electrode is greater for white iron than for gray.

According to Dr. Paul L. T. Heroult, a plant capable of producing 120 tons of pig iron per day would cost about $700,000 and the cost of making the iron would be $10.69. This estimate is based on the assumption that ore contains 55 per cent iron, and costs $1.50 per ton.

From the results obtained in the Sault Ste. Marie experiments, it would seem that the electric furnace stands a chance of competing with the present methods in the production of pig iron, at least under certain favorable conditions. For the manufacture of ferro alloys of high percentage, *Electrochemical and Metallurgical Industry* says that "the electric furnace now stands supreme, specially in the manufacture of those ferros in which a highly refractory oxide (like that of titanium) is to be reduced." For the manufacture of high-grade steel, the same authority says: "The electric furnace seems to be destined to gradually replace the crucible steel process. The advantages of the electric furnace are lower cost of operation, due to larger units and consequently smaller labor charge per ton of output and greater durability of the electric furnace. The cost of electric power is a comparatively small item in this case, and becomes almost insignificant if fluid steel is supplied from an open-hearth furnace or from a Bessemer converter to an electric furnace for refining. It is likely that steel which has been refined in the electric furnace at a small cost may be used in future to a much greater extent than is now possible with the high price of crucible steel."

W. B. Jr.

TECHNICAL CONCLUSIONS FROM THE GLIDDEN AUTOMOBILE TOUR.

The Horseless Age, August 1 and 8, 1906.

The Glidden contest is an annual event in the automobile world which is especially designed to test the economy and reliability of the contesting machines under severe touring conditions. The route of this year's race was about 1,200 miles in length, starting at Buffalo, N. Y., thence eastward across the State and northward to Montreal, and up the St. Lawrence River. Then the route took a southward turn again down through the White Mountains, winding up at Bretton Woods, N. H. This route was a severe one in many respects, including stretches of sandy and rough roads, and many exceedingly steep grades. Albert L. Clough contributes to the *Horseless Age* the main results of his observations made during the tour as to the strength and efficiency of the various parts of the automobile mechanism. We give them here in abstract:

One noticeable feature of this year's contest was that all the American cars are of practically the same type. This standardization of form makes it possible to speak quite generally of the technical merits and demerits of the contesting vehicles as a whole. The greatest chance of drawing comparisons is in considering the details of construction, which still show some diversity. One of the principal points of interest relates to the efficiency of the air-cooled car, five of which entered the contest. This air cooling of the vehicle engine of large power is a distinctly American proposition. The writer kept close watch of the performance of the air-cooled cars and found his previous judgment as to this question far more than substantiated. Of the five air-cooled cars that started from Buffalo, four finished at Bretton Woods, two making perfect scores. At no time have any of the air-cooled engines been noticed in a dangerously overheated condition, and they have not found the pace at all in excess of their capabilities, at least so far as the cooling question is concerned. American builders would do well to give more attention to this type of engine instead of following foreign models so closely as they have done.

The weakest part of the chassis has been demonstrated to be the running gear of the car. This is the salient technical conclusion to be drawn from the contest. It looks as if the engine of the average car possesses enough power to strain the supporting framework to the point of destruction in a few thousand miles of hard running over unimproved country roads, without being itself injured to any serious extent. In the matter of axles, for instance, this tour must have proved an eye-opener to many manufacturers as well as to the owners of the machines themselves. There are very few tubular front axles to be found upon the contesting vehicles which have not more or less of a permanent set, while most I-section axles are in as good condition as they were at the start. It is to be presumed that the tubular axle will now be finally discarded, except for use upon very cheap cars. Notwithstanding the use of the shock absorber, the spring must be characterized as one of the weakest parts of the car. The spring problem is a difficult one and has not as yet received the intelligent attention it demands. It would seem that certain manufacturers must either increase their spring lengths with a corresponding increase of sectional dimensions or else resort to some other form of spring than the half-elliptic, such as the platform type or the double elliptic type. This change may come about when the very low-hung body is seen to be no special desideratum. Is it certain that the list of special steels has been exhausted in a search for the best spring material? Possibly some such improvement as has lately been made in crankshaft material might be made in spring stock.

The brake problem is substantially solved. Some of the cars have required rather frequent brake adjustment, but the problem is merely one of providing more liberal wearing surface. The manufacturers of these cars will, without doubt, profit by the knowledge acquired in this tour. The same cannot be said with so much truth of the steering gears. They have been given severe usage over rocky, sandy and winding roads, and many of them have become quite loose, requiring considerable adjustment. The presence of back lash and the shocks communicated through imperfectly reversible steering mechanisms conspired to very much fatigue and lamed many of the operators.

Both chain and shaft drives have shown themselves able to do their work successfully under difficult conditions. There seems to be no reason to credit the assertion that is sometimes made that the shaft drive is inapplicable to heavy cars of high power.

Perhaps the most astonishing and welcome fact brought out is the great reliability and endurance of the engines. There have been practically no cases of serious mechanical engine troubles. There have been some few valve replacements, but very little tightening of bearings or anything of that sort. Not a few of the motors are too good for their cars and too powerful, capable of driving them to destruction in a short period. One can hardly refrain from being enthusiastic regarding the remarkable performances of these motors. There is no other thermal prime mover which approaches the vehicle engine in reliability, automaticity, and weight efficiency, considering the conditions under which it is used. During the whole tour there was substantially no trouble from faulty ignition. Clutches and change gears also seem to have been developed to a satisfactory degree of strength and reliability. As regards the ratio of speed reduction, however, the writer cannot help thinking that there are not a few high-grade cars which do not possess a large enough gear reduction upon the slowest speed to give them a safe margin of hill-climbing capability. Cars with three or four forward speeds employ the lower gear only at infrequent intervals. When its use becomes necessary, however, it should be so low as to over-

come all car resistances, up to the limit of traction; that is, it should be capable of slipping the rear wheels on good footing. Twenty per cent hills are always likely to be met with in country touring, and the purchaser of a costly touring car does not care to be stalled at such grades, as were not a few of the cars in this tour. A suspicion sometimes crosses the mind as to whether the modern car with the engine in the front part carries sufficient weight upon the driving wheels to meet unfavorable conditions.

To one who observed the slipping of driving wheels on one of the hills met with on the tour which presented a muddy surface, the question must have seemed a pertinent one. In this respect the discarded engine in the body was superior. Another difficulty met with on steep hills was the failure of the gravity gasoline system. On a 20 per cent grade with the tank under the front seat the head of gasoline may be lowered about eight inches, which may be enough, if the fuel supply is low, to reduce the head to nothing.

Besides the vindication of the capability of air cooling for protracted touring purposes, there is one other technical innovation which has had a successful try-out in this contest. I refer to the two-cycle engine. Though there was but a single car of this type in the run, which did not achieve a perfect score, it was penalized by a few points only, due to delays which it was understood were in no way connected with the application of the two-cycle principle. This car finished the tour apparently as well as did the majority of four-cycle cars with its propulsive mechanism in excellent condition. To all who looked forward to the demonstration of the fitness of valveless motors to automobile practice, this fact will be presently significant.

It was indeed a cruel fate which pursued the steam cars entered in this contest and led to the total destruction of two of them. Although these cars have been developed to a high pitch of reliability and efficiency in every other respect, there is always the hazard of the exposed flame to contend with. Gasoline cars were enormously in the majority in this tour, and at least two cars were overturned and several ditched, yet none of them met with destruction or damage by fire. All efforts to render the steam car as safe as the gasoline car in point of fire hazard must be made against heavy odds, and must be expected to result fruitlessly.

This tour has proven a wonderful demonstration of the reliability of the American motor car, being impressive on account of the very considerable number of them which completed the run without penalization, and on account of the large proportion of the entrants that finished. Of the three foreign-built cars in the tour, none escaped penalization and only one of them finished at all. While this fact may not be deeply significant, it will perhaps tend to strengthen the impression that it is folly to pay a fancy price for foreign cars when fully as serviceable American machines can be bought for far less money.

THE GAS TURBINE.

Dr. C. E. Lucke, *Engineering Magazine*, August, 1906.

Dr. Lucke gives a great deal of information on the gas turbine, based on actual experiments; this information is not encouraging to those who expect soon to see gas turbines in general use, but it will be of decided value to those who are or intend to be experimenters in this field, as it points out the almost insurmountable obstacles that stand in the way of success. The main features of the paper are given in what follows:

Inventors and engineers have experimented with complete gas turbines, with and without steam, as well as with the various elements going to make up the system, such as the compressor, the fire, the nozzle and the turbine wheel. Some of these experimental combinations have been made to run, but cannot be regarded as working machines merely because they run. To receive any consideration they must approach the steam or gas engine in efficiency, in reliability, life, space occupied, and other commercial features.

It is to be regretted that by far the most of the experimental results along these lines have been suppressed. The inventors or experimenters apparently hoped to achieve something wonderful, something which must not be disclosed to the world too soon, and so they have concealed their early work. Later, when the machine was built and operated, the failure was so humiliating that in some cases the experimenter was ashamed to publish his results, and in other cases it appears that large sums of money were spent, and those who spent it did not feel inclined to give results to the world, obtained at such large individual expense. If the results of every man who had experimented with this problem had been published, there would have been less experimenting. It is also extremely probable that if the results had been given freely to all who were interested in the problem, we would to-day be nearer success, or more certain of its impossibility.

In a paper published about a year ago, I pointed out one of the difficulties of obtaining a practical gas turbine—free expansion by means of the nozzle. That there were other difficulties was well known at that time, but it seems to me that the most basic difficulty was the one previously made prominent. It was found by experimenting with nozzles that the temperature drop in the nozzles between the place of no velocity and high pressure and the place of maximum velocity and low pressure was very small, and averaged about 12 per cent of what is theoretically possible. Since that time, the temperature drop in an actual turbine has been measured and compared with the theoretical pressure drop and the performance of the turbine operating with air has been measured. For convenience of operation the air was cold air, whereas in the practical gas turbine the air would be hot and possibly more or less mixed with steam, or possibly no air at all but carbon dioxide and nitrogen. In any event, the working fluid would be largely a perfect gas. The turbine used was a De Laval standard 30-horsepower machine intended for steam at 110 pounds pressure and having six nozzles. The turbine wheel runs at 20,000 revolutions per minute, and the power shaft 2,000 revolutions.

With each type of nozzle three different initial pressures were used, each with a different number of nozzles. Readings were taken of the temperature of the air entering the turbine and the temperature of the air in the exhaust chamber, with the corresponding pressures. This turbine was fitted for six nozzles in all, grouped in three pairs of two each. These nozzles were all designed for 110 pounds initial pressure at three different back pressures—atmospheric, 25.5 inches vacuum and 26.3 inches vacuum.

In the best results the figures are as follows: Initial temperature and pressure, respectively, 98 degrees and 85 pounds; final temperature and pressure 58 degrees and 0.03 pound; theoretical temperature, 123 degrees; range of temperature observed, 40 degrees; theoretical drop, 221 degrees; per cent of theoretical realized, 18.1. In the poorest result the temperature dropped 8 degrees, from 90 degrees to 82 degrees, while theoretically it should have dropped 188 degrees, the pressure drop being from 48 pounds to 0.12 pound. The per cent of the theoretical realized in this case was only 4.3. From this it appears that the temperature drop varies between 4 and 18 per cent of the theoretical drop. These results were determined with respect to speed also, which varied from 520 to 1,920 revolutions per minute.

The experiments fully confirm those previously reported and the conclusions drawn from them, that the temperature drop in free expansion with such nozzles as have been used indicates very small conversion of heat into work. Investigations by the author among men who have worked with compressed air and with jets and nozzles has failed to develop a single case where there occurs a substantial cooling of perfect gases by free expansion. One man is probably better fitted to express an opinion than any other, by reason of his life work—Dr. Ernest Körting, inventor for many years of jet apparatus of all sorts, and of gas engines and producers. After a life spent in such work with signal success, he sets it down as a fact that he has never noted a single case of efficient expansion of gases, as shown by temperature drop.

To secure some idea of the attitude of other engineers toward this gas engine situation, I addressed the following series of questions to a number of men whose opinions seem to be desirable:

a. Do you consider that there is anything theoretically im-

possible in the production of a gas turbine, with or without the use of steam?

b. Do you consider that there is anything practically prohibitive in carrying out the necessary process to produce a gas turbine, using either perfect gas or a mixture of perfect gas and steam?

c. What do you consider are the prospects of overcoming such difficulties as exist?

d. Do you consider that there is anything theoretically or practically difficult in the compressor part of the system?

e. In the combustion chamber of the system?

f. In the control of hot gases alone or with steam?

g. In the nozzle part of the system?

h. In the turbine wheel part of the system?

i. In any other part of the system?

These men represent the steam turbine field, the gas engine field. and scientific men not identified with any particular field. The replies are given in the following:

Prof. R. C. Carpenter:

"Respecting the future commercial success of the gas turbine, I would state that I have formed an opinion which is unfavorable, due to the extremely high temperature which the working parts must be subjected to.

"Quite a number of experiments respecting the gas turbine have been carried on in our laboratory during the past eight or ten years. I felt at first that the machine could be made a practical success, but latterly I have concluded that the practical difficulties were almost insurmountable.

"In my opinion there is nothing in fault with the theory of a gas turbine without the use of steam, but I do not believe that there is any immediate prospect of securing metals which will stand the high temperature required for the nozzles and buckets.

"Respecting the use of a combined gas and steam turbine, I have at the present time no definite or positive information which will enable me to express an opinion as to its future practicability. I think, however, that a turbine working on such a combination might have a fighting chance of succeeding."

Prof. Sidney A. Reeve:

"*a.* No.

"*b.* At present, yes.

"*c.* The prospects are excellent. The gas turbine is a new problem. The devices already standard in engineering practice were developed to meet earlier conditions. The conditions of the new problem are different. The usual period for the experimental development of a solution of the problem of building old devices along new lines is all that intervenes between the present and a practicable gas turbine.

"*d.* Theoretically, no. Practically, yes. The compressor is the only unsolved and difficult part of the problem.

"*e.* No, either theoretically or practically.

"*f.* With permanent gases, yes. With steam, no.

"*g.* No.

"*h.* No.

"*i.* No."

Prof. William T. Magruder:

"*a.* I see nothing theoretically impossible in gas turbines, although I am not prepared to predict how economical they will be in the use of fuel and repairs in practice.

"*b.* I feel that the obtainable temperatures which are desired for maximum efficiency may cause great difficulty, unless a suitable porcelain can be obtained.

"*c.* I have faith enough to believe that the difficulties will be overcome.

"*d.* I am not prepared to say that the compression is absolutely necessary, and believe that the difficulties peculiar to the problem can be overcome. A motor-driven, 550-revolution, 3,000-pound pressure, four stage air compressor at 85 per cent pneumatic efficiency is the latest success in this line.

"*e.* Your work is an answer to this question.

"*f.* Without steam it is the most serious proposition.

"*g.* Cannot say. Would try porcelain.

"I believe that a solution of the problem will be effected, which, in its way, will be as novel as the steam turbine. I would, however, prefer not to make any prediction or statement at present."

Mr. F. E. Junge:

"*a.* No.

"*b.* No.

"*c.* Prospects are good if efficiency of proposed turbine is second consideration.

"*d.* Nothing.

"*e.* Yes; difficulty of cooling.

"*f.* Yes; thermal inefficiency when steam is generated by injecting water into combustion chamber before or during combustion.

"*g.* No, if properly designed.

"*h.* Yes, impossibility of cooling blades and finding proper material to stand high temperatures continuously.

"*i.* None but lack of interest in manufacturing circles and among investors."

Prof. Elihu Thompson in his reply says that the gas turbine is certainly a very complex problem, and he is not prepared to answer the questions put, definitely, at this time. He sees, however, no theoretical impossibility in the gas turbine, with or without steam, but considers the practical problems of the greatest difficulty, especially the compression problem. The construction and operation problems are certainly difficult, and considerable time will probably elapse before any thoroughly workable gas turbine is produced, and the problem of its competing with other machines is naturally somewhat doubtful.

W. L. R. Emmet, after a few preliminary remarks relative to the theory of the subject, concludes his answer as follows:

"Even when due allowance is made for these difficulties, theory would indicate that fair economy might be obtained from a gas turbine. The development of any practicable process of this kind involves a great amount of thought and labor, and all that I can say of this process is that it seems to afford a less attractive field for development than many others to which a competent engineer might devote his energies."

After a review of the whole situation, it appears that theoretically there is nothing impossible in the problem, and such difficulties as exist are purely practical but of no mean order of magnitude. So great are the difficulties encountered by those who have experimented, and so great are those that are foreseen by practical men, whose lives are devoted to overcoming difficulties, that those who are engaged in trying to perfect such a machine as this are warned of the certainty that their efforts will be fruitless for a long time at least, that much money will be spent with no tangible results, and that the practical gas turbine is a long way off. W. B. Jr.

CURRENT PRACTICE IN PETROL ENGINE DESIGN.

G. W. Rice, *Sibley Journal of Engineering*, June, 1906.

This paper is an abstract from a thesis by the author for the M. E. degree. Mr. Rice gives working formulas for the dimensions of the various parts of petrol engines, especially the light-weight type used in automobiles. These formulas are deduced from actual practice, as exemplified in the latest designs of such machines, and are of special value to designers. All the essential information is given in the following abridgment of the paper. The author says:

It is the object of this paper to derive rational machine design formulas for the different parts of a petrol engine with the constants of the formulas derived from practice. In May, 1905, an explanation of this project, together with data sheets, were mailed to 200 builders, and from these, data on about seventy-five engines were obtained. In order to get the maximum explosion pressure, which we need in finding the stresses in the engine parts, the assumption is made that the compression pressure is one-fourth of the maximum explosion pressure. This assumption is very nearly correct and is used throughout this article.

Ratio of Length to Diameter.

While in stationary gas engines running at slow speed, the stroke is about 1.5 times the bore for thermodynamic reasons, in high-speed petrol engines the consideration of piston speed outweighs the former and in some cases it is shorter.

$l =$ cylinder length in inches.

$D =$ diameter of cylinder in inches.

Values of l and D were plotted, giving 1.07 as mean value of "A" in formula $l = A\,D$.

The designer's formula is,

$$l = 1.07\,D.$$

$D =$ the cylinder bore.

$l =$ length of stroke.

R. P. M. = revolutions per minute.

$C\,l =$ clearance as a fraction of piston displacement.

The equation for the maximum horsepower is a rational formula, the constant in it being based on the current practice of 1905 and 1906.

$$\text{D. H. P. per cylinder} = \frac{D^2 \times L \times \text{R. P. M.} \times (.48 + 0.1\,C\,l)}{14000.}$$

Thickness of Cylinder Wall.

This depends on the stress which can safely be allowed for continuous repetition. On account of the desire for lightness

and the stiffening action of the jacket wall, this stress is taken as high as possible; in fact, instead of allowing the usual constant for reboring, it was found on plotting the data from engines in actual practice that this constant had a negative value of 1/8 inch.

t = thickness of cylinder wall.
s = allowable stress per square inch.
p = maximum explosion pressure.
D = cylinder diameter.

The design formulas are then:

$$t = \frac{p\,D}{5300} - \tfrac{1}{8}'' \quad \text{(Light automobile practice).}$$

$$t = \frac{p\,D}{3700} - \tfrac{1}{8}'' \quad \text{(Medium weight practice).}$$

$$t = \frac{p\,D}{3200} - \tfrac{1}{8}'' \quad \text{(Heavy marine practice).}$$

$$t = \frac{D}{16} \quad \text{(Rough rule, not considering pressure).}$$

Thickness of Integral Cast Cylinder Heads.

The common form of head is that of a flattened ellipse. Liberal fillets should be used where the head joins the cylinder wall, and the head may be gradually reduced in thickness as you approach the center. Close to the cylinder wall $t = 0.005\,D\,\sqrt{p}$; at the center $t = p\,D \div 1.5\,s$.

Thickness of Jacket Wall.

This is made as thin as it can be cast in the foundry; in some cases it is deposited electrolytically of copper; in other cases the cylinder is cast without a jacket, turned up inside and out and a thin metal jacket of copper or brass applied. This latter practice has come to the front a great deal during the last year. In cylinders made in this manner you can be sure that the cylinder wall has a constant thickness, which is something which cannot be said of the ordinary type, it is also of a very light construction.

Length of Piston.

The normal pressure between piston and cylinder wall for any point in the piston stroke is equal to pressure on piston head divided by the ratio of connecting rod to crank length. By assuming an average clearance and different ratios of connecting rod to crank, it was found that the average pressure on the piston head when the connecting rod and crank were at right angles, giving the maximum normal pressure on the piston, was 0.23 times the maximum pressure. The design formulas are:

$$l = 0.0167\,p\,\frac{D}{c}.$$

$$l = 1.125\,D.$$

p = maximum pressure on piston in pounds per square inch.
c = ratio of the connecting rod to the crank.
l = length of the piston.

Thickness of Rear Wall of Piston.

t = thickness of unribbed rear wall of piston.
p = maximum pressure in pounds per square inch.
D = diameter of cylinder.

The designer's formula is

$$t = 0.0034\sqrt{p} \times D.$$

By plotting between piston head thickness and cylinder diameter, we get the rough design formula: Allow 1-16-inch thickness per inch of cylinder diameter.

Dimensions of Piston Rings.

In the consideration of piston ring dimensions, the first proportion with which we are interested is the diameter to which the outside of the cast-iron ring is finished. This must be a diameter slightly greater than the bore of the cylinder so as to furnish a sufficient packing action to the piston. This diameter is the same for eccentric turned rings as for non-eccentric ones, and by plotting between ring diameter and cylinder diameter it was found that the ring was turned to 1.03 times the cylinder diameter.

Right here it might be well to say that due to the heat of the burning gases expanding the piston head, that end of the piston has to be made slightly smaller down to the first ring than the rest of the piston, this allowance is usually taken as 0.001 inch per inch diameter of cylinder.

For plain rings of constant thickness the width was found to be 0.07 of the cylinder diameter and the thickness of the ring to be 0.5 of the width. The number of rings used by different builders varies widely, the common practice being three at the head end of the piston and one, known as an oil ring, at the open end.

The designer's formulas are:

$$d = 1.03\,D, \quad w = 0.07\,D, \quad t = 0.5\,w.$$

Design of Wrist Pin.

The average pressure on the piston pin will be the same as on the crankpin, neglecting inertia effects.

p = maximum pressure in the cylinder.
d = diameter of wrist pin.
l = length of wrist pin.
D = cylinder diameter.

The designer's formulas are:

$$d\,l = 0.000445\,p\,D$$

$$l = 2\tfrac{1}{4}\,d$$

$$d\,l = \frac{0.7854\,\pi\,D^2}{7}$$

$$d = 0.225\,D$$

Crank Pin Design in Engines with Main Bearing Each Side of Crank Pin.

Below is given data on the ultimate strength of 15 crank shafts having an average ultimate strength of 95,000 pounds per square inch. (See July, 1905, *Horseless Age*.)

Autocar	85,000	Pierce	105,000	Columbia	90,000
Moline	90,000	Lozier	100,000	Covert	80,000
Packard	100,000	S. and M.	125,000	Acme	90,000
St. Louis	70,000	Pierce	105,000	Thomas	105,000
Nameless	85,000	Haynes	90,000	Welch	115,000

and the very latest practice is using steel of special mixture giving it greater hardness and a very high tensile strength.

The designer's formulas for this type of crank shafts—

$$d = \frac{D}{43.2}\sqrt{p} \text{ for diameter of pin.}$$

$$l = 1\,1/3\,d \text{ for length of pin.}$$

Crank Pin Design in Engine not having Main Bearing Each Side of Crank Pin.

Assuming that for this type of engine $d = 2$ inches on the average, approximately,

$$d = \frac{D}{36.5}\sqrt{p} + 0.9''.$$

$$l = 3.75\,d - 3.75''.$$

A general average of all cases shows that the diameter of crank pin $= \dfrac{D}{2.8}$. Again the general average shows that the projected area of the crank pin is 1/5 of the piston area.

Design of Main Bearings.

d = diameter of main bearing.

The length of main bearing per cylinder in four cylinder engines with five main bearings is 2.82 d.

The length of main bearing per cylinder in four cylinder engines with three main bearings is 1.54 d.

The length of main bearings per cylinder in two-cycle engines is 4.45 d. (This applies to one- and two-cylinder engines only.)

The relative lengths of these bearings, among themselves, varies with the cylinder arrangement—whether they are cast in pair, separately, etc. In all cases, the bearing at the flywheel or power end of the shaft is made longer than any of the others because the weight of the wheel rests almost directly on it and, therefore, the average total pressure is much greater than on the others.

The designer's formulas are—for length of journal—given above.

$$\text{Diameter} = 7.24 \sqrt[3]{\frac{\text{H. P. per cylinder}}{\text{R. P. M.}}}.$$

Crank Throws or Webs.

d = diameter of main bearing.
d' = diameter of crank pin.
h = depth of crank throws.
b = thickness of crank throws.
b' = thickness of crank throws on flywheel side.
b'' = thickness of long crank throws.

The designer's formulas are:

$$d^3 = b\,h^2$$
$$h = 2.6\,b$$
$$b' = 1.25\,b$$
$$h = 1.33\,d'$$
$$b'' = 1.25\,b'$$

Inertia Effects of Reciprocating Parts.

F = inertia effects in pounds per square inch of piston area.
W = weight of (piston + 2/3 connecting rod).
N = R. P. M.
r = one half stroke, in feet.
c = ratio of connecting rod to crank.
D = cylinder diameter, inches.
w = weight of reciprocating parts per square inch of piston area.

$$F = \frac{W \times N^2 \times r \times 0.00034}{0.7854\,D^2} \times \left(I + \frac{I}{c}\right)$$

Now by plotting we find that the weight of reciprocating parts is 0.55 pounds per square inch of piston, and the value of "c" is 4. We may then rewrite the above equation as follows:

$$F = 1.25\ (w \times N^2 \times r \times 0.00034).$$
$$= 1.25\ (0.55 \times N^2 \times r \times 0.00034)$$
$$= 0.0002435\ (N^2 \times r)$$

Giving us a simple equation for inertia effects of a given engine at a given speed.

Stress in Connecting Rod Bolts.

The stress in the bolts of the connecting rod is almost entirely due to the inertia pressures at the end of the stroke. This stress may be found from the preceding formula by plotting the maximum inertia pressures at the engines' rated speed with the reduced bolt area. That is the area at the bottom of the threads. The average ratio of thread area to bolt area is 0.65 for the sizes commonly used in automobile engine construction.

Flywheel Design.

In the design of a flywheel for an automobile engine we have a proposition entirely different from the design of a flywheel for any type of stationary engine. In the automobile the function of the flywheel is not to keep the engine speed constant, but to furnish a storage reservoir of energy sufficient to start the car under any working conditions or to keep the engine turning over when running at very low speed and under heavy load. Current practice does not help us as much as it might in this particular, for the weights of flywheel used for the same powered engine varies widely among the different builders. The weight depends, first upon the diameter, and this depends, to a large extent upon where the wheel has to be put; second, upon the weight of the loaded car, relative to the power of the engine. It also depends upon the gearing ratio of the car and other things relative to the car design.

By plotting between engine stroke and flywheel diameter, we find that the diameter varies from 4.9 to 2.9 times the engine stroke. The average value of flywheel diameter being 3.5 times the engine stroke.

Engine Weight.

Instead of comparing the engine weight with the horsepower, as is usually done, let us compare it with the cubic inches of piston displacement. By plotting between the weight of the complete engine and cylinder volume in cubic inches, we find:

$$W = 1.125\ V + 100.$$

On plotting between engine weight without flywheel and cubic inches of piston displacement, we find:

$$W = 1.125\ V.$$

This indicates that irrespective of the power of the engine, the builders have always used a flywheel of about 100 pounds weight.

By plotting between engine weight and horsepower, we find the average value to be 17.6 pounds per horsepower.

Diameter and Lift of Exhaust Valves.

D = cylinder diameter.
L = length of stroke.
N = R. P. M.
S = allowable speed of gas in feet per minute = 3,520.
d = diameter of exhaust valve.
h = lift of exhaust valve.

In high-speed engines the ring area open to gas passage, seems to be the all important item, and not the diameter of the valve itself. The tendency being to keep the valves large in diameter, and to make the lift as small as possible, 7/16 inch was the highest lift noted on about 80 engines, with cylinder sizes up to 7 × 9 inches, while the theoretical lift would be ¼ of the diameter of the valve. About 5/16 inch is a popular lift in this country, while the French use much lower lifts. These low valve lifts are used in order to get a quick closing valve and to prevent hammering of the cams on the valve push rods.

The designer's formula is:

$$D^2\ L\ N = 84{,}500\ d\ h.$$

Valve Thickness.

For the thickness of the exhaust and inlet valves the formula of Reuleaux may be used:

$$t = r\sqrt{\frac{p}{s}}$$

t = thickness.
r = radius of supporting circle.
p = maximum pressure in cylinder.
s = fiber stress.

Or as given by another designer this is modified to read:

$$t = 0.45\ d\sqrt{\frac{p}{s}}$$

The maximum normal pressure of the valve on its seat is given by several authorities as 900 pounds per square inch and when a conical seated valve is used the angle is usually taken between 45 and 70 degrees, which makes the effective lift of the valve equal to the real lift times the sine of the valve angle which may be approximated at 0.75. Diameter of valve stem is taken as 1/5 valve diameter.

Inlet Valve Design.

Most that has been said relative to the exhaust valve may be applied to the inlet valve. The valves themselves are very often made interchangeable, but they are usually given different lifts, that of the inlet valve being smaller. The designer's formula is:

$$D^2\ L\ N = d\ h \times 107{,}000.$$

Speed of Exhaust Gases through Pipe.

D = cylinder diameter in inches.
L = length of stroke.
N = R. P. M.
S = allowable speed of gas in feet per minute = 6,550.
a = area of exhaust pipe (nominal).

The designer's formula is:

$$a = \frac{D^2\ L\ N}{50{,}000}.$$

Speed of Gases through Inlet Pipe.

The designer's formula is:

$$a = \frac{D^2\ L\ N}{80{,}000}.$$

S = 10,000 feet per minute.

Two-cycle Port Design.

The design of ports for two-cycle engines depends upon two important factors. First the height of the port determines the valve timing of the engine, and this timing must be arranged to give the proper results when the engine is running at slow speed. Next, the ports must be extended around the cylinder until a sufficient area is obtained to give the required engine speed. The two points then to consider are valve timing, and limiting gas velocities. This valve timing is very nearly constant for all the engines, the average values being 88 degrees for the inlet ports and 110 degrees for the exhaust ports. The velocity of the gases through the ports was found by assuming full port opening from the time the port began to open to the time it closes. The exhaust gas velocity was found to be quite constant at about 7,500 feet per minute. The inlet gas velocity varied with the crank case pressure, but as this pressure is either about 4 or 8 pounds, we find two values for inlet gas velocity. The gas velocity corresponding to 4 pounds is 12,000 foot-minutes, while that corresponding to 8 pounds is 24,000 foot-minutes.

Compression Pressure and Clearance.

Theoretically the compression of an engine depends upon the clearance, and from theory we can compute the compression of any engine of which we know the clearance volume. In practice we never get a full cylinder of explosive mixture, and the percentage which we do get depends upon the engine speed, the amount the engine is cooled, the temperature of entering charge, and the make of carburetor. The compression pressure varies directly as the square root of the R. P. M. and inversely as the square of the diameter of cylinder and inversely as the clearance to the 4/3 power.

A curve plotted between compression pressure and

$$\sqrt{\frac{\text{R. P. M.}}{D^2 \times Cl^{\frac{4}{3}}}} \text{ gives } \sqrt{\frac{\text{R. P. M.}}{D^2 \times Cl^{\frac{4}{3}}}} = \frac{1}{2.25} \text{ compression absolute } + 15.$$

W. B. Jr.

DENATURED ALCOHOL.

Consular Report No. 2666.

The strongest alcohol of commerce in the United States is usually 95 per cent alcohol and the price varies from $2.30 to $2.50 per gallon, showing that the greater part of the cost is due to the revenue levied by the government. The greater part of the 60,000,000 gallons of alcohol consumed in the United States is used in the manufacture of whisky and other beverages. The revenue tax prevents the use of alcohol to any great extent in the industries of the country. The bill passed at the last Congress, designed to promote the use of untaxed alcohol in the arts and as fuel, takes effect January 1, 1907. The first effect of free alcohol will be, it is said, to supplant the 12,000,000 gallons of wood alcohol which are used in the manufacture of paints, varnishes, shellacs, and other purposes. Another use that is expected of denatured alcohol is in the manufacture of certain products, such as dyestuffs and chemicals, which cannot now be manufactured commercially in this country because of the high cost of alcohol, and which are imported largely from Europe. A very rapid development of the industry of manufacturing chemicals as a result of free alcohol is looked for. In the production of alcohol there is always formed as a by-product a certain amount of fusel oil, which is very useful in manufacturing lacquers which are used on metallic substances, fine hardware, gas fixtures, and similar articles. The industries manufacturing these wares will undoubtedly receive a great stimulus as a result of cheaper fusel oil caused by the increased production of alcohol.

The use of denatured alcohol as a fuel has yet to be fully developed. Although alcohol has only about half the heating power of kerosene or gasoline, gallon for gallon, yet it has many valuable properties which may enable it to compete successfully in spite of its lower fuel value. In the first place it is very much safer. Alcohol has a tendency to simply heat the surrounding vapors and produce currents of hot gases which are not usually brought to high enough temperature to inflame articles at a distance. It can be easily diluted with water, and when it is diluted to more than one-half it ceases to be inflammable. Hence it may be readily extinguished, while burning gasoline, by floating on the water, simply spreads its flame when water is applied to it. Although alcohol has far less heating capacity than gasoline, the best experts believe that it will develop a much higher percentage of efficiency in motors than does gasoline. Since gasoline represents only about 2 per cent of the petroleum which is refined, its supply is limited and its price must constantly rise, in view of the enormous demand made for it for automobiles and gasoline engines in general. This will open a new opportunity for denatured alcohol. Industrial alcohol is now used in Germany in small portable lamps, which give it all the effects of a mantel burner heated by gas. The expense for alcohol is only about two-thirds as much per candlepower as is the cost of kerosene. Even at 25 or 30 cents a gallon, denatured alcohol can successfully compete with kerosene as a means of lighting.

* * *

SPROCKET WHEELS FOR ORDINARY LINK CHAINS.

In determining the pitch diameter of a sprocket wheel for use with the ordinary elliptical link chain, the geometrical problem involved is that of finding the diameter of a circle whose circumference can be spaced off into a given number of alternate long and short chords of given lengths. The dimensions of the chain and the number of teeth desired in the wheel form the conditions which determine the pitch diameter. As may be seen by referring to Plate I. in the Supplement, the form of sprocket wheel there detailed has one tooth for every two links. The dimensions which concern us in finding the pitch diameter of the sprocket wheel are: d, the diameter of the stock from which the link is made; and r, the pitch of the chain or length of the opening in the link. These dimensions are shown in the upper right-hand figure of Plate I. Given the number of teeth desired in the wheel, and these two dimensions, d and r, the formula for the pitch diameter, which is taken from a German handbook (*Hütte, Des Ingenieur Taschenbuch;* page 502—I.) is

$$D = \sqrt{\left(\frac{r}{\sin \alpha}\right)^2 + \left(\frac{d}{\cos \alpha}\right)^2}$$

in which $\alpha = \dfrac{90°}{N}$ when $N =$ the number of teeth. Referring to Fig. 1 below, which shows the impossible three-tooth sprocket for the sake of having the lines on a large scale, the derivation of the formula can readily be followed. The pitch circle passes, naturally, through o, the center of the circle

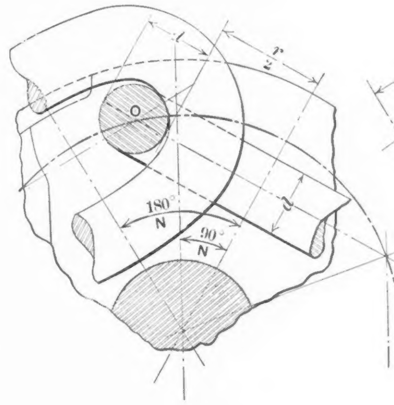


Fig. 1.

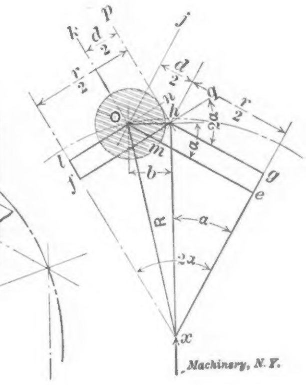


Fig. 2.

representing a medial cross section of the link which lies flat. The polygon in this case will be a six-sided one, of which three sides are each equal to $r + d$, while the three alternate sides are each equal to $r - d$. Referring to Fig. 2, which is a skeleton diagram of Fig. 1, $l\,o$ is half the length of one of the short sides of the hexagon, $e\,o$ is half the length of one of the long sides of the hexagon, while R is the radius of the pitch circle. To determine the value of R proceed as follows: First (graphically) with the center of the sprocket at x, draw

$g\,x$ and $f\,x$ at an angle of α degrees either side of vertical line $h\,x$. Construct the two right-angle triangles, $h\,g\,x$, and $h\,f\,x$, in which $h\,g$ and $h\,f$ each equal $r/2$ or half the pitch of the chain. To find the position of the center of the circular section of the flat link, draw the line $j\,o$ parallel with $g\,x$ at a distance of $d/2$ to the left of h. Draw also line $k\,o$ parallel to $l\,x$ at a distance $d/2$ to the left of h. Then, evidently, the point of intersection o will be the location of the center of the chain section, and R will be the radius of the pitch circle.

To solve this mathematically the problem may be analyzed as follows: In addition to lines previously drawn, draw $h\,m$ tangent to the circle representing the section of the chain, continue $l\,o$ to n and draw $o\,h$. We have first to prove that $\angle h\,o\,m = \angle h\,x\,g = \alpha$. By construction $h\,f$ and $h\,g$ are portions of sides of a regular polygon of n sides, 6 in this case. The exterior angle of a regular polygon is equal to $360°/n$; therefore $\angle\ q\,h\,g$, the exterior angle of $\angle\ f\,h\,g, = 360°/n = 2\,\alpha$. By construction, the sides of $\angle\ n\,o\,m$ and $\angle\ q\,h\,g$ are parallel, therefore the angles are equal; therefore $\angle\ n\,o\,m = 2\,\alpha$. Since $p\,h$ and $m\,h$ are both tangent to the circle, it can be easily shown that line $o\,h$ bisects $\angle\ n\,o\,m$. Therefore $\angle h\,o\,m = \alpha$. Since $o\,m = d/2$, $o\,h = \dfrac{d}{2 \times \cos\alpha}$. Again, since $h\,g = r/2$, we have $h\,x = \dfrac{r}{2 \times \sin\alpha}$. We know that $o\,h\,x$ is a right-angle triangle, since line $o\,h$ bisects the exterior angle of the regular polygon represented by lines $h\,f$ and $h\,g$; this polygon has its center at x. Triangle $o\,h\,x$ is therefore a right-angle triangle whose sides $o\,h$ and $h\,x$ we have just obtained, and from which we may readily obtain the value of R. This will evidently be expressed by the following equation:

$$R = \sqrt{\left(\frac{r}{2 \times \sin\alpha}\right)^2 + \left(\frac{d}{2 \times \cos\alpha}\right)^2}$$

Rearranging this equation to give the value of the pitch diameter directly we have

$$D = \sqrt{\left(\frac{r}{\sin\alpha}\right)^2 + \left(\frac{d}{\cos\alpha}\right)^2}$$

The tables in Plates II. and III. of the supplement give the pitch diameters of sprocket wheels for use with chains of various regular sizes from 3/16 inch stock to 1⅝ inch stock, for sprockets having 5 to 30 teeth. For instance, for an 18-tooth sprocket with a chain made from links of stock ½ inch in diameter the chain link being 2½ inches over all, the diameter will be 17.21. At the right of each of these tables are given two columns headed "x" and "y." These give constants to which reference is made in the dimensions on Plate I. These tables were contributed by Mr. F. Wackermann, chief draftsman of the Jones & Laughlin Steel Co., Pittsburg.

* * *

THE STRENGTH OF GEAR TEETH.

The formula known as "Lewis formula," given in Kent's handbook and in general use for determining the strength of gears is $W = S\,p\,f\,y$ in which

W = the load transmitted.
S = the safe working stress of the material, taken at 8,000 pounds for cast iron when the working speed is 100 feet or less per minute.
p = the circular pitch.
f = the face in inches.
y = a factor taken from a table furnished whose value depends upon the shape of the tooth.

Our contributor, Mr. E. H. Fish, of the Worcester Polytechnic Institute, has prepared a tabulation of the quantities involved in this formula (see Supplement) which makes it somewhat more convenient for use than is the original form in which it was published. The formula proposed by Mr. Fish is

$$W = \frac{S\,f\,W'}{1{,}000\,P}$$

in which

W = the load transmitted in pounds.
S = safe fiber stress.
W' = load carried by a gear 1 diametral pitch, 1 inch face at a maximum fiber stress of 1,000 pounds.
f = face in inches.
P = diametral pitch.

In obtaining the value for W', which is here given for 15-degree involute teeth only, the corresponding value of y in the table given in the handbook is multiplied by 1,000 to include the factor for maximum fiber stresses, and again by π to change the factor from one depending on circumferential pitch to one depending upon diametral pitch. This, carried through the scale from 12 teeth to the rack, gives the table shown in Plate IV. of the supplement; the table of stresses is self explanatory.

To show the use of this formula and the tables with it, let it be required to find the safe load which can be carried by a 4-pitch gear, 40 teeth, 2 inches wide, running with a peripheral speed of 600 feet per minute. This gear is made of steel and is supposed to be subject to considerable shock, so we will use the lower value given for that material in the table of stresses. With a surface speed of 600 feet per minute, the table gives 8,000 pounds as the safe fiber stress for a steel gear subject to shock. The value for the factor W' for 15-degree involute tooth in a gear having 40 teeth is found from the other table to be about 340. Substituting our known quantities in equation,

$$W = \frac{S\,f\,w'}{1{,}000\,P}$$

we have

$$W = \frac{8{,}000 \times 2 \times 340}{1{,}000 \times 2} = 2{,}720 \text{ pounds.}$$

* * *

FRESH WATER PONDS IN THE OCEAN.

A curious phenomenon often noticed in navigation is the existence of shallow ponds or lakes of fresh water on the surface of sea water. The cause of this isolation of fresh water is not fully known but is believed to be principally due to the melting of icebergs, and a subsequent lack of wind and currents to cause a mixture. A still more curious feature is that these strata of fresh water oppose considerably greater resistance to the progress of a vessel than does salt water. An explanation offered is that the passage of the vessel causes two sets of waves in the two strata of water—in short, relative movement which causes friction and retardation of motion. That such relative movement exists was proven experimentally. A large plate glass tank was filled to a certain depth with salt water and then a layer of fresh water was carefully poured on the surface so that two distinct layers of water were obtained. The salt water had been blackened with Chinese ink so that the junction of the two layers of water was clearly distinct. A boat model towed through the tank produced waves which were photographed and these photographs, it is claimed, showed conclusively that waves were set up at the boundary line between the two liquids. The experiment was also extended to actually demonstrate that a greater loss of headway does take place in a tank filled with layers of water of different density than in one filled with water of the same density throughout.

* * *

THE DRYING OF DAMP GOODS IN WET WEATHER.

During the rainy season, when the air is nearly saturated with moisture, drying takes place very slowly under ordinary circumstances, even if a steady current should pass the material to be dried; but as the capacity of air to absorb moisture varies with the temperature, it may be made more absorbent merely by heating it. For example, when the rain falls heavily in Bombay the temperature is frequently 82 degrees F., while the moisture is 90 per cent of saturation. This represents eleven grains of water per cubic foot. By heating the air to 110 degrees the saturation is reduced from 90 to 42 per cent, roughly, and the air is thus able to absorb as much again of water as it at first contained without being damper than its original condition. In this manner, by simply controlling the temperature of the current of air its drying power may be assured whatever the state of the weather may be.

THE MANUFACTURING ADVANTAGE.

TECUMSEH SWIFT.

When manufacturing businesses prosper and grow to the dimensions of some of our modern concerns they are very apt to lose some of their earlier advantages, and one of these is the closeness of touch, the mutual understanding and sympathy, the complete and automatic cooperation of the manufacturing and the selling ends. It is of the greatest importance that these two should grow up together and that in later years they should not be separated. Some of the most continuously prosperous concerns are those which have kept the manufacturing and the distributing branches of their businesses in the same location and in unsevered relationship. It is sufficient to mention the Brown & Sharpe Mfg. Co., the Warner & Swasey Co., the Eastman Kodak Co., and the National Cash Register Co. Surely each of these, and many others which might be mentioned, would have as much reason for locating their main business offices in New York City as most of these who are there, but it is easy to believe that any of these would be losers rather than gainers by such a change.

I, of course, am not writing with the slightest idea of changing the trend of business practice, but only in the way of suggesting how to make the best of it. It would be well for all of us here in the big New York offices and better for the companies with which we are connected if we were better acquainted with our shops and factories. If any of us here at the selling end, as we call it, ever run short of talking material and need filling up, the factory is the place to visit and to hang around. The true inwardness of all our product is revealed there, and the ability to tell the actual facts as to the construction and operation of all the machines we make is the surest way not only to the immediate selling of any specific thing but also to the building up of lasting business. Knowing that the product of our company has made its way upon its merits we can only hope to see it still progress along the same road. It is most essential that the fullest information concerning our output be widely spread abroad, and it can't be spread too thickly.

Not only should the public know as much as we can get it to know about the machines we build, but it would be well, also, for it to know about the magnificent and costly facilities we have for the building of them. The advantage which the large concern, when dominated by large ideas, has over the small competitor with small ideas is one of the most evident facts of modern manufacturing, and the calling of attention to it is legitimate business.

There is no occasion for hesitation about revealing things. Just as it has been demonstrated to pay best to tell the truth, the whole truth and nothing but the truth about the machines and tools of our entire list, I think it pays also to tell just as straight and just as fully and freely about our ways and means for making them. It may be that there are things at our factory which are more or less trade secrets and which it may be to our advantage not to let our competitors know about. If anyone knows what these things are he knows more than I do.

There are, however, many things at our factory which cannot possibly require any holding back or any reticence about, and which may be really among the strongest of talking material. It is possible for me to be very specific and precise here. Of course all the world knows our company as the largest builders of—say, gas engine pumps—in the world. The other day I was at the factory and I came along by a radial drill where a fellow was drilling a gas engine pump bedplate. I guess it was a 20 × 24-inch, and we all know that is a pretty big casting. It is about 15 feet long and 4 feet wide. The bedplate had been planed or milled—it might be revealing one of these trade secrets to tell how this was done —and the planing had left the casting entirely ready for the drilling. You should realize what an immense jig was used for this job. It was as big as the entire top of the bedplate and stiff and heavy enough to stand rough handling and to insure precision in use. It was a jig complete in every respect, with full provision for accurate setting and secure holding and with steel thimbles for all the holes to be drilled. One end of the jig was just planed to fit in between the planed jaws of the main bearings, and two feet resting on the planed flat surfaces of the crosshead slides were finished vertically on the outsides to just coincide with the planed outside edges of the slides. This located the jig laterally and other means equally simple and effective located it longitudinally, and then with screws set up horizontally in the different directions to keep it from sliding, and bolts at different points to hold it down it was all ready for the drilling. The casting was on rollers on the floor and the radial drill in combination with one or two movements of the casting lengthwise commanded all the holes.

This jig of course implies other jigs for the cylinders and the other pieces whose holes must absolutely coincide with those drilled in the bed; and this jig would be entirely worthless without the others, so that the entire outfit cost a lot of money. There is, of course, nothing about the jig requiring any special talent to design or any special skill to work. There are hundreds of men in hundreds of shops who could get up such a set of jigs for such a job, some of them perhaps not as good as this, some perhaps a little better, and there is absolutely no secret or novelty anywhere about the job.

The advantages resulting from the use of the jig in the processes of manufacture are more or less evident, although it takes some thought to get completely at the number and magnitude of them. The most evident and immediate advantage is in the saving of time. Suppose that the cylinders were laid out and drilled first, and the caps for the main bearings and the upper crosshead slides, and then that these all had to be carefully located on the bed "in the good old-fashioned way," to have the holes scratched through them on to the bedplate surface. Then these pieces would all have to be lifted off and the holes would then be prick-punched all around. Then there would be the careful starting of the drill for each hole, the coaxing of the centers this way or that and the not very accurate drilling of the holes after all.

When it came to the final setting and bolting on of the several pieces there would be more or less trouble and trimming of the holes and filing here and there, and the pieces finally fitted to one bed would never quite correctly fit any other. Throughout the job thus done "in the good old way," or even in the way of the small shop to-day, greater skill and care would be required all through, the job would not be nearly as good in any respect, and the cost of the work would be two or three times as great.

I don't know a thing about the figures in this case, but I suppose that when you can build gas engine pumps with cylinders as large as 20 × 24 inches, or other styles and sizes in lots of ten at a time, I am willing to believe that the entire jig outfit will pay for itself on the first batch, that the customers will get much better machines with full interchangeability, and that the company in all subsequent uses of the jigs will get a big interest on their far-seeing investment.

It is not merely, nor hardly at all, the capital of the big company which brings it this opportunity which it uses to its great advantage. It is the large sale of each established line of its product which alone warrants the expenditure. The small concern which must build its gas engine pumps in ones or twos, and which must be continually changing its product in some of its details in the struggle to keep up with the procession, cannot afford and cannot make it pay to rig up in this way, so that no matter how much they may know about the way to do it they must still "jog on the footpath way."

The seeing of the opportunities for economy with precision, and the constant and persistent taking advantage of them at the factory cannot be too highly commended, and the highest commendation lies in full appreciation, and what we fully appreciate we are likely to talk long and loud about, so the one thing to do is to insist upon it that all of our customers, especially those of the future, shall be completely informed as to how we do things, both for their good and for our own.

Whether machines shall be built in quantities which will warrant elaborate and costly preparation is, after all, in the hands of the selling force, for they must sell in commensurate quantities to sustain the production rate, and this is more likely to be realized and worked out to success the more the two ends of the business come in touch with each other.

CHARLES E. BILLINGS.

REPRESENTATIVE AMERICAN MECHANICS AND ENGINEERS.

Charles E. Billings was born in Weathersfield, Vt., December 5, 1835. In his early years he worked in the blacksmith shop of his father, and at the age of seventeen he went to work in the machine works of Robbins & Lawrence Co., Windsor, Vt., which was one of the pioneer machine-building concerns of this country. While serving his apprenticeship the company built a considerable number of milling, drilling, rifling and gun-stock turning machines for the Enfield Armory of Great Britain for the manufacture of the celebrated Enfield rifles. His foreman was Frederick Howe, of Windsor, Vt., who later became superintendent of the Providence Tool Co., and was later superintendent of the Brown & Sharpe Mfg. Co. The Robbins & Lawrence Co. also manufactured a firearm for the United States government known as the Harper's Ferry rifle, and Mr. Billings spent most of his time in the gun department. Here he first became acquainted with the primitive methods then employed for forging the various parts of guns, which he has described as follows (see MACHINERY, May, 1895): "A heavy cast-iron block called the 'sow block' with a suitable opening in the top for the lower die was held fast by keys and stock to guide the upper die, termed the 'jumper.' In the face of the die the forms to be forged were cut as at present, the power being applied by hand hammers and sledges wielded by the smith and his helpers, on the upper die, with the heated bar of metal held between them. Much time was spent in distributing the stock on the end of the bar of metal before the sledging took place in order to have the metal flow properly to fill the points of the die."

It was here, also, that Mr. Billings first saw a drop hammer, which was the forerunner of the present type. It was a crude affair with cast-iron base and uprights, the latter carrying a shaft at right angles on which was mounted a loose pulley for a belt and also a spool with flanges, for winding the belt. One end of the belt was attached to the spool and the other to a hammer. A clutch on the end of the shaft operated by a lever wound the belt on the spool and raised the hammer which was held at the height required by a dog on the side of the upright. This was tripped by a pedal when a blow was delivered.

Mr. Billings' experience in the gun department of the Robbins & Lawrence Co. naturally inclined him to this kind of work, and after becoming of age (1856) he went to Hartford, Conn., and entered the employ of Colt's Patent Firearms Mfg. Co. as a toolmaker and die-sinker in the forging department. Here he first saw a practical working drop hammer, being one designed by Elias K. Root, then superintendent of the works. In this way it happens that Samuel Colt is generally credited with being the pioneer in the manufacture and use of modern drop forgings or "machine blacksmithing," as they are sometimes called.

Mr. Billings remained at Colt's from 1856 until 1862, when he accepted a position with the gun factory of E. Remington & Sons, Ilion, N. Y., to introduce the manufacture of drop forgings. E. Remington & Sons had heretofore never used drop forgings in their gun work, but when the various governments required wrought frames for army and navy pistols it became necessary to use them. Mr. Billings superintended the drop forging plant and introduced his method of forging pistol frames, which was somewhat different from that used by Colt. During the four years he stayed at Ilion a saving of $50,000 was effected on government contracts by one simple feature of his method which saved about one pound of metal for each pistol frame, which had hitherto been rejected as waste. The iron being imported at the time was worth 20 cents per pound, hence the importance of avoiding all unnecessary production of scrap.

Returning to Hartford in 1865, Mr. Billings acted as superintendent of the manufacturing department of the Weed Sewing Machine Co., where he introduced drop hammers for forging the parts of sewing machines, especially the shuttles, which had formerly been made in several pieces brazed together. In 1867 he patented a process for drop forging shuttles from a single piece of steel, thereby effecting a great improvement in this part. In 1869 Mr. Billings left the Weed Sewing Machine Co., and in company with Mr. Christopher M. Spencer organized the Billings & Spencer Co. to manufacture sewing machine shuttles. The company also was interested in the manufacture of the Roper repeating shot gun, which, however, resulted unsatisfactorily, and in 1870 the manufacture of drop forgings was taken up as a specialty and has continued so since. Mr. Billings has made a considerable number of inventions, including wrenches, ratchet drills, measuring instruments, etc. A variety of machinists' tools are now manufactured by the company, being finished from the drop forgings in the machine department of the plant.

Although closely identified with the early development of the drop forging business and in a large sense a pioneer in the industry, Mr. Billings considers that one of his most important achievements made in this line was as late as 1886, when his attention was first called to the existing method of making commutator bars for electric generators while on a visit to the Edison Electric Works. These parts, at that time, were made of two pieces of copper, set together so as to form the well-known characteristic shape, and secured by pins and solder. This method of manufacturing was expensive and frequent interruptions of circuit were caused by the parts becoming separated, thus necessitating the taking apart of the commutator before the part could be gotten out and repaired. Mr. Billings suggested that the commutator segments could be drop forged to shape from pure copper, but his idea was not considered feasible by the foreman of the department. Nevertheless, upon returning home, dies were made and in a few weeks he sent to the Edison Co. drop-forged commutator bars made from pure copper having a homogeneous molecular structure throughout and of great density, and obviously of high electrical conductivity. The cost of making commutator segments was greatly reduced by the drop-forging process and the efficiency of these parts increased to a corresponding degree.

Mr. Billings is past president of the American Society of Mechanical Engineers, succeeding from the vice-presidency in 1895 upon the death of Mr. E. F. C. Davis, then president.

* * *

THE MILAN EXPOSITION.

The Milan Exposition has been somewhat of a disappointment to machinery exhibitors who have gone to a heavy outlay in order to secure a creditable representation. The extreme heat in Italy during the summer months has kept the attendance at a low figure, but it was expected that this would improve as the weather became cooler, as there are many attractive features in the exposition and in the progressive city of Milan, which is the principal manufacturing center in Italy, the machine tool industry being particularly active at

present on account of the expansion in the automobile trade. The exposition is peculiar in occupying two distinct and separate sections of ground some distance apart, connected by an electric elevated railway, which is a small mint to its owners. The exhibits occupy one section of the grounds, and the other, which comprises the municipal park, is devoted largely to amusement features, being laid out in the attractive way which Europeans are past masters of.

There are two exceedingly good exhibits of American machine tools at the exposition—made by Stüssi & Zweifel of Milan, and Alfred H. Schütte. Stüssi & Zweifel showed six Brown & Sharpe machines in operation—a No. 3-A universal milling machine, a No. 5 plain milling machine, a No. 3 universal grinding machine, a No. 13 automatic gear cutting machine, a No. 2 automatic screw machine, a No. 13 universal and tool grinding machine—and the following: Five Pratt & Whitney machines, including a 10-inch toolmaker's engine lathe, a 2 x 26-inch turret lathe, a 6 x 48-inch thread milling machine, an automatic cutter grinder, a 12-inch measuring machine and a case of Pratt & Whitney's small tools, assorted; five Hendey-Norton machines, including a 24-inch x 12-foot lathe, 14-inch x 6-foot lathe, with taper attachment; 16-inch x 8-foot lathe, with taper attachment; 18-inch x 8-foot lathe; 24-inch shaper; a Barnes drilling machine and grinding machine, and a 36-inch Bullard vertical turret lathe.

The other exhibit is made by the Milan house of Alfred H. Schütte, showing a 21-inch Gisholt turret lathe and tool grinder, a Potter & Johnston semi-automatic turret lathe, new model, 8½ x 16-inch; a Lodge & Shipley 8-inch x 10-foot lathe for high-speed steel; an 18-inch x 8-foot Bradford lathe; two Cincinnati drills, 21-inch and 32-inch; a No. 1 Bickford radial (improved pattern); a Baker Bros. vertical cylinder boring machine; a Baker Bros. key seater; a No. 3 Landis universal grinder; two Cincinnati milling machines, No. 3 plain and No. 1½ universal; a Cincinnati tool grinder; two 2-inch Cleveland automatic lathes, one with three-hole turret head and one with five-hole turret head; a No. 4 Acme automatic lathe with four spindles; a 26-inch x 6-foot Gray planing machine; a complete plant of pneumatic tools with air compressor by the Consolidated Pneumatic Tool Co., Ltd., an American Machine Tool Company's oil separator; a Washburn drill grinder; a Peerless belt lacing machine, and a set of Starrett's tools and gages.

Other American firms show miscellaneous machinery, and there is the usual variety of manufactured articles representing the different European countries.

* * *

TIME SAVING IN EXTRACTING THE SQUARE ROOT.

It had been the writer's practice for some time, when doing work which required frequent extracting of the square root of quantities, to work with a handbook on his table opened to the table of squares and square roots. Often, however, the three places to which the primary number in these tables are generally carried did not suffice to give the required degree of accuracy. Under these circumstances the extraction of the root was carried as much further as was necessary by the usual methods outlined in the arithmetics. In looking over an algebra the other day, however, the writer's attention was called to a principle which was there explained and proven, to the effect that after $n+1$ figures of a root have been obtained, the remaining figures may be found by simple division. This principle has been found so useful that it is here described with the thought that it may save others quite a bit of mathematical drudgery.

Suppose it is required to extract the square root of 152,409,694. Pointing off in the usual fashion and finding the first three figures of the answer, either by comparing with a table of square roots as suggested, or by the ordinary method, our problem stands as follows, with the remainder given.

$$\begin{array}{r|l} 152{,}409{,}694 & 12300 \\ 151{,}290{,}000 & \\ \hline 1{,}119{,}694 & \end{array}$$

We have now found $n+1$ or three figures of the root. We can find the n or two remaining figures, as suggested above, by simple division. Multiplying the partial root by 2 in the usual manner and dividing the remainder by it we have:

$$\frac{1{,}119{,}694}{2 \times 12{,}300} = 45 +$$

which gives 45 as the next two figures of the root, so, adding the five figures thus obtained together, we have 12,345 + as the result. If we desire to proceed still further we may again find by simple division the answer to four places of decimals. We have found $n+1$, or in this case five figures, so that it is possible to obtain n or four figures more. After performing the division indicated above, we have 12,694 as the remainder; subtracting from this remainder the square of the portion of the root just found. This gives us

$$\begin{array}{rl} \text{Remainder} = & 12{,}694 \\ 45^2 \quad = & 2{,}025 \\ \hline & 10{,}669 \end{array}$$

Proceeding as before to divide this remainder by twice the quotient of the root already found and carrying the division out to the fourth decimal place we have

$$\frac{10{,}669}{2 \times 12{,}345} = 0.4321 +$$

which may be added to that part of the root previously found, giving us 12,345.4321.

It would now be entirely possible, having found nine figures of the root, to obtain eight more in the same way. To do this we would, as before, subtract from the remainder of the last division the square root of the quotient obtained by that division, and then divide the result by twice the portion of the root already found, carrying the division out to eight new places, which may be added to the answer. This process will be found easy with or without the help of the handbook, and gives the required results with considerably less calculation than would otherwise be necessary. A similar plan may be used in extracting the cube root. In this case after $n+2$ figures of the root have been found, n more figures may be obtained by dividing the remainder by three times the portion of the root already found. As this operation is repeated, however, it becomes more cumbersome in the case of the extraction of the cube root.

The process as applied to finding the square root may be expressed by the following rule:

1. Having found any number of figures of the root by any process, subtract the square of the portion of the root thus found from the original quantity.
2. Divide the remainder found, in Operation 1, by twice the portion of the root already found, carrying the quotient to one less number of figures than there are figures in the portion of the root already found. This quotient is to be added to the portion of the root already found.
3. Subtract from the remainder left after the division in Operation 2, the square of the quotient therein found, and divide the result by twice the whole root, so far as found, carrying the division to one less number of steps than there are places in the root so far as found. Add this quotient to the root so far as found.

On analysis Operation 3 will be found to be identical with Operations 1 and 2 combined. Operation 3 may be repeated until the cows come home, with increasing difficulty, but with increasing effectiveness in the number of new figures added at one operation.

R. E. F.

* * *

We are informed by Mr. J. F. Lockwood, manager of the Security Elevator Safety Co., New York, that the Cruikshank elevator safety was *not* involved in the scheme which certain elevator interests tried to foist on New York city some years ago; this took the shape of an ordinance which would have prevented other elevator safeties being used in that city, hence would have effected a virtual monopoly. Mr. Lockwood tells us that the Cruikshank device, owned by his company, has been adopted in a large number of the best buildings in New York City and in many of the government buildings throughout the United States. We are glad to make this correction, with reference to the article "Shock Absorber" in the July issue, and to know that the parties representing this interesting and valuable device were not in the deal referred to.

A NOVEL CRANK ARRANGEMENT FOR SINGLE-ACTING INTERNAL COMBUSTION ENGINES.

Mr. Robert H. Ramsey, of Philadelphia, has brought out a novel arrangement of crank mechanism for use with single-action internal combustion engines, by means of which the side thrust on the piston, during the power stroke is considerably reduced, and at the same time the portion of the revolution effected by this stroke is increased, while the length of crank for a given stroke is reduced. The difference between the ordinary and the Ramsey arrangement is that in the latter the center line of the cylinder runs in a line tangent to the crank circle, as is illustrated in Fig. 1. The solid circle shows the path of the crank in the Ramsey mechanism, and the broken line circle is the crank path of the ordinary

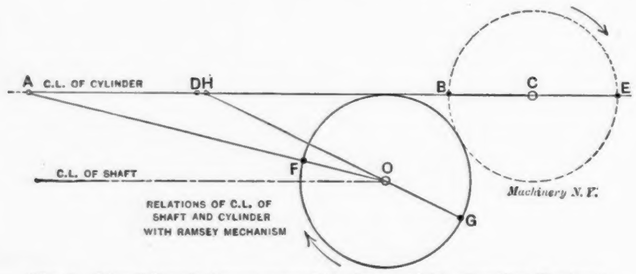


Fig. 1. Novel Crank Arrangement for Internal Combustion Engines.

design. In the latter design, the stroke *A D* of the piston is equal to the diameter *B E* of the crank circle, but in the Ramsey design the stroke for the same length of crank is *A H*. During the power stroke, the crank revolves from *F* over the upper part of the circle to *G*, which, as will be seen, is more than half a revolution. It will also be seen that for quite an angular distance just before reaching the half stroke the connecting rod is very nearly in line with the cylinder,

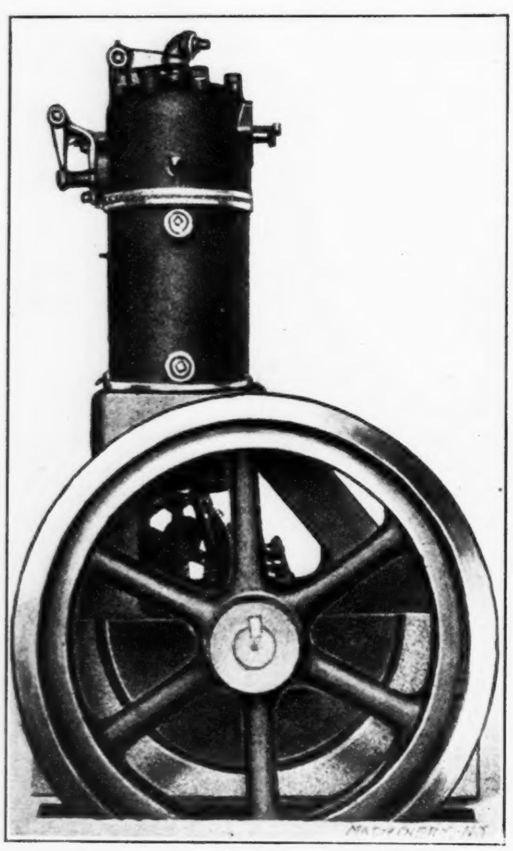


Fig. 2. Ramsey Engine showing Offset of Cylinder.

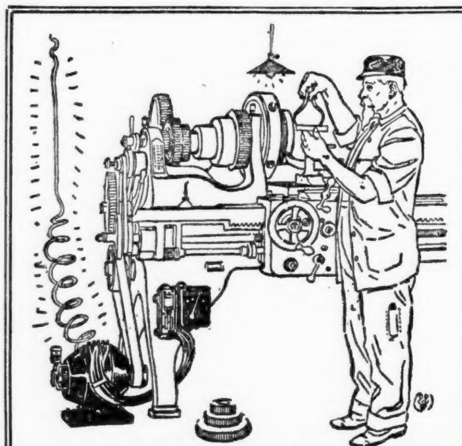
and at the beginning of the stroke the angle of the connecting rod is less than with the centrally located crank shaft. At the end of the stroke the connecting rod angle becomes greater, but at this point the pressure in the cylinder is greatly reduced; therefore, taking the power stroke as a whole, the side thrust is considerably less than with the standard arrangement of crank, and on that account the connecting rod can be made shorter. During the compression stroke the connecting rod angle is greater than with the central crank shaft, but at the same time the compression pressure is only about one-quarter of the working stroke pressure, and during the first part of the stroke, when the angle is greatest, the compression is very low, so that taken all in all, what is gained in reduced side thrust on the power stroke is much more than what is lost during the compression stroke.

W. B. Jr.

[The Ramsey crank mechanism discussed in the preceding paragraphs has been fully described in most of the technical papers of the country. We do not, however, remember to have seen it mentioned that one of the most interesting things about it is the fact that it at once invites discussion, first, as to the patentability of the principle involved, and second as to the usefulness of the device. If the patent granted covers the principle of locating the center line of the cylinder tangent to the circle described by the crankpin, this claim could be avoided by moving the cylinder slightly to one side or the other of its position. If the absolute location of the cylinder axis is not important, but merely the principle of offsetting the cylinder, that has been used for many years, notably in the case of the Westinghouse "standard" steam engine, of which thousands have been built with the center line offset by an amount equal to one-half the crank length. Granting its patentability, a little thought will still show that the claims made for the device, while they may be valid, cannot be expressed and proved in the simple fashion in which the promoters of the device have undertaken to do it.—Editor.]

* * *

SOMETHING NEW IN MOTOR DRIVE!



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—From Chicago *Daily News*.

* * *

A BURGLAR-PROOF VAULT.

Mr. Morris M. Defrees, a civil engineer of Indianapolis, has designed a safe deposit vault, which is described in the *Cement Age*. The initial step in the construction of this fire- and burglar-proof vault consists in the erection of a cage around which concrete is poured. This cage covers the sides, top and bottom of the vault, and is composed of a lattice work of ¾-inch gas pipe, each pipe having inside a steel bar ½-inch in diameter. Assuming that the burglar had the good fortune to get through the concrete and the pipe, he would meet an insurmountable difficulty in striking the bar, for his saw would then come in contact with a movable body on which no purchase is possible. It is suggested that the reinforcing cage be made double with the vertical and horizontal bars of the outer cage staggered in relation to those of the inner cage. Mr. Defrees advises, in the making of the concrete, a mixture of 1 part of cement and 3 of sand as being harder than concrete containing stone or gravel.

LETTERS UPON PRACTICAL SUBJECTS.

THREE-SPINDLE DRILLING ATTACHMENT.

There is nothing elaborate in the construction of tools for the manufacture of dental chairs, because there are constant changes being made in the design of the product which necessitate sometimes a radical change in the tools, even to discarding some of them altogether. The part of the chair called the "cylinder" has three holes drilled in it, equally spaced around its periphery. These pieces have heretofore been drilled at the rate of two per hour, but with the three-spindle attachment herein described, we drill five per hour with accurate results. We have a number of Snyder drill presses in the shop, and it is to one of these that the device is shown attached in Fig. 1. Its members are fastened together in such a way that they may be detached easily and the press used for other work. Details of the device are shown in Fig. 2.

Referring to this cut the outline shows a bracket-shaped piece, *A*, planed to fit the column of the press; the gibbs *D D'* are held on with retaining bolts (not shown). The flange of the bracket *A*, shown at *e*, is bolted to the spindle bracket and the whole fixture is attached to the machine by the bolts at this place. The spindle bracket when lowered to the limit of its travel, lets the bearing of *A* drop off the bearing on the column. Member *B* is a separate casting, but when bolted to *A*, forms a single unit with it. *B* is the carrier of the three spindles which are driven by cast-iron spur gears on their upper extremity; these three gears (26 teeth, 8 P. one-inch face) are driven by a gear of the same size, in the center, keyed to the spindle of the press. The thrust of the central spindle against the member *B* is taken up by a taper shank piece that carries on its end a ball thrust; this is seen at the dotted lines in the side view, Fig. 2.* Ball thrust bearings are provided for each of the three spindles also, as shown. Each spindle is fitted with ball chucks and collets and in drilling this identical job, two sets of Novo drills are employed; the ones seen in the photo are ½-inch drills with extension shanks; on the box in front of the press is the other set, 55/64 inch diameter.

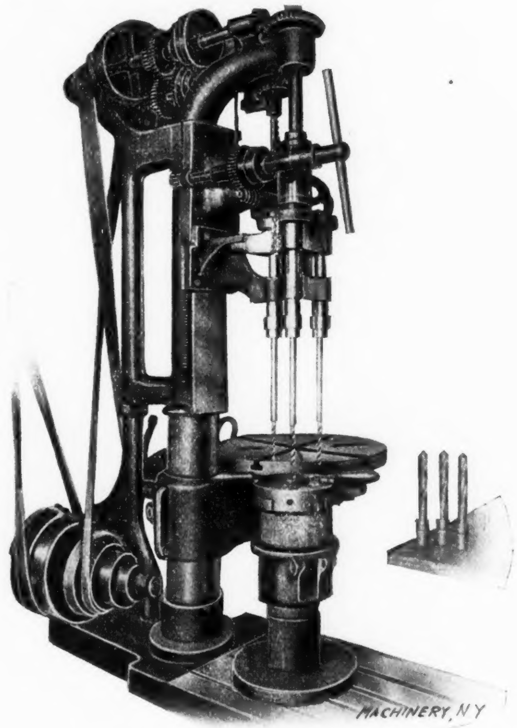


Fig. 1. Drill Press with Three-spindle Drilling Attachment.

The jig is located central with the spindle by means of a hole in the bed, which is exactly in line and central with the spindle; into this hole fits a projection or lug on the bottom of the jig itself.

To remove this attachment, the jig is moved to one side, the drills withdrawn, and the table swung back into place; the fixture is then lowered until the chucks rest on the table, the bolts at *e* are released and the spindle is then free to be raised up and out of *B*. The central gear comes with it, but as it is a slip fit on the spindle it is quickly removed. The fixture being now below the before mentioned bearings of the column it can be laid aside and the press used for other work.

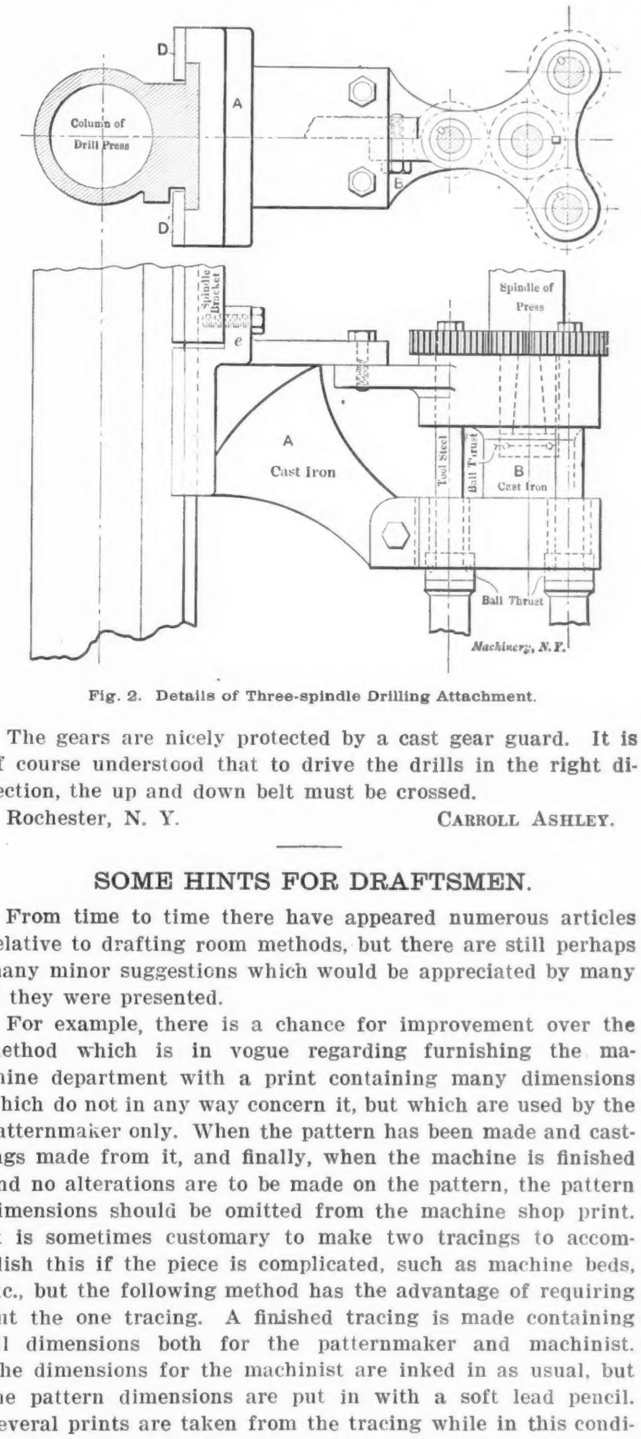


Fig. 2. Details of Three-spindle Drilling Attachment.

The gears are nicely protected by a cast gear guard. It is of course understood that to drive the drills in the right direction, the up and down belt must be crossed.

Rochester, N. Y. CARROLL ASHLEY.

SOME HINTS FOR DRAFTSMEN.

From time to time there have appeared numerous articles relative to drafting room methods, but there are still perhaps many minor suggestions which would be appreciated by many if they were presented.

For example, there is a chance for improvement over the method which is in vogue regarding furnishing the machine department with a print containing many dimensions which do not in any way concern it, but which are used by the patternmaker only. When the pattern has been made and castings made from it, and finally, when the machine is finished and no alterations are to be made on the pattern, the pattern dimensions should be omitted from the machine shop print. It is sometimes customary to make two tracings to accomplish this if the piece is complicated, such as machine beds, etc., but the following method has the advantage of requiring but the one tracing. A finished tracing is made containing all dimensions both for the patternmaker and machinist. The dimensions for the machinist are inked in as usual, but the pattern dimensions are put in with a soft lead pencil. Several prints are taken from the tracing while in this condition, one furnished the pattern shop and as many filed away as desired. The lead pencil dimensions are then erased and the tracing is ready for making prints for the machine shop. In this way the patternmaker can readily understand and pick out his figures, and the machine shop print is kept free from unimportant dimensions which ofttimes cause considerable trouble.

It is sometimes desired to make a tracing of cuts from catalogues, books, etc., and to do this without removing the page. Perhaps it is not well known that by wetting the edges of the starchy side of tracing cloth and rubbing it on the page that it will adhere firmly and the tracing can be done on the dull side without much trouble.

I have found it a good plan when leaving a tracing on the board at night to remove all the tacks from the drawing and tracing except the one which is in the center of the top edge and the one which is in the center of the bottom edge. This allows it to go and come and to be tightened readily in the morning.

In spacing a line for screw threads when it is desired to represent the V, the thread gage furnishes the means as well as anything could; simply choose the pitch and make the impressions.

I have often found that when lines on an outer circle are to be drawn tangent to an inner circle that a cardboard disk is a good substitute for the eccentrolinead and is as much better than a circle as is a pin put in the center for radiating lines, than a lead pencil point.

In order to have a scale divided to one-fourth and one-half size it was necessary to make one, as they are not on the market. The object of making one was for checking purposes only; it could hardly be used for constructing for any length of time, as it is made of paper strips pasted on a wooden strip and shellacked over. The divisions are on bristol board and are engine divided. These paper scales can be procured for a small sum. This makes an excellent rule for checking drawings made one-fourth, to one-half size.

It is well to have a piece of blotting paper 2 x 3 inches hung on the wall, for when it is needed it is wanted in a hurry, and this makes a convenient place for it.

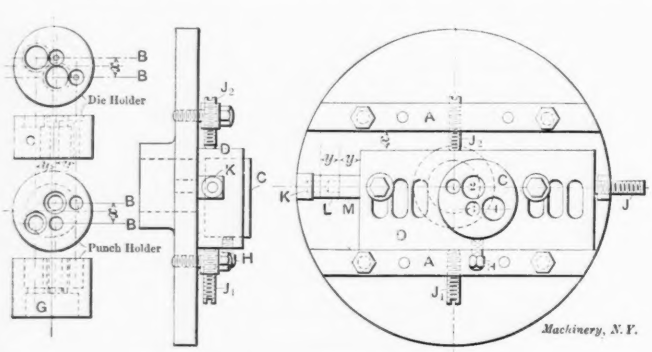
Various means have been devised to keep tracings flat in drawers. They will continue to curl up if the ink is put on the smooth side, but will lay flat of their own accord if ink is put on the dull side.

A small flat oil-can with screw top is very convenient to have among the draftsman's kit; if oil is used frequently on the screws and nuts of instruments they not only work better but last much longer. WINAMAC.

A FACEPLATE RIG FOR BORING PUNCH AND DIE HOLDERS.

At *C* and *G* are shown a die holder and a punch holder respectively. In making them the important point to be considered is that the lines *B*, *B*, in each case, must be parallel. The rig used to accomplish this is shown in the cut.

The faceplate of the lathe in which the holes were to be bored was taken to the drill press, where it was drilled and tapped to receive the "hexhead" screws and dowel pins by which the two steel strips *A* and *A* were fastened to it. In clamping these pieces to the faceplate, cardboard strips about 1/8 inch thick were inserted between them and the faceplate.



Faceplate for Boring Punch and Die Holders.

The faceplate was next taken to the planer and leveled there with the surface gage, face up, and the inner edges of the strips *A* were planed parallel to each other. The cardboard, in this operation, saves the surface of the faceplate from injury.

Block *D* was next machined to such a width that, when placed between the strips *A* and *A*, dimension *x* was the same as on pieces *C* and *G*. In the center of this block a recess was formed to receive the blank for the punch and die holders, and a setscrew, *H*, was used to hold them in place. The block *D* was slotted as shown to accommodate the two bolts used to secure it to the faceplate. Screws J_1, J_2 were tapped into the side strips and in a post at the edge of the plate to adjust block *D*. In another post, *K*, were set two plugs, *L* and *M*, of which the latter had a projection which telescoped in the first, which in like fashion set in the post. Dimension *y* of these plugs was made the same as *y* on punch and die holders *C* and *G*.

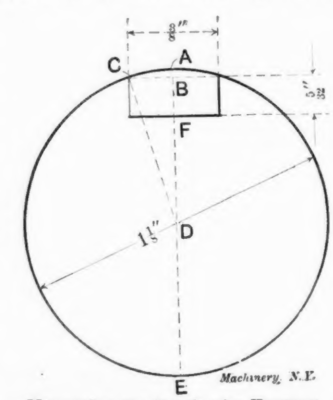
In using the device, the work is clamped in the block *D* by setscrew *H*, and with the parts arranged as shown, screws *J* are tightened up, the block is clamped to the faceplate, and hole No. 1 is bored. The screws are loosened, distance piece *M* is removed, and, with the screws tightened up again and the other parts arranged as before, hole No. 2 is finished. It is, of course, understood that screw J_1 has not been used all this time. Screw J_2 is now withdrawn and J_1 tightened until the block *D* seats against the upper strip *A*, when it is clamped and hole No. 3 is bored. Distance piece *L* is then removed and the last hole, No. 4, is completed.

This arrangement assures the parallelism of lines *B* and *B* in the work, and also makes it certain that the punch will exactly match the die. R. E. HARRYMAN.

Louisville, Ky.

MEASURING KEYWAYS.

I was once milling some keyways that were supposed to be pretty accurate, but the dimension given for depth was not such as could be measured accurately. The depth was given as 5/32 inch at the sides of the cut; now, the cutter could be set for depth comparatively accurately by raising the milling machine table until the cutter was cutting the full width of the keyway and then raising the table 0.15625 inch (= 5/32). This is not very reliable, however, as you cannot see within 0.003 to 0.005 inch and after taking the cut a burr is thrown up at the edge. In filing this off one is apt to take off more or less of the shaft with it, and furthermore the only way to get the depth measurement is with a scale. The first keyway that the boss inspected, seemed to him a trifle deep, but I filed off a little more of the burr (?), and that made it all right. But I wasn't satisfied and wanted some way to measure the depth accurately, with a micrometer, if only to ease my own conscience. I could measure the distance, *F E*, from the bottom of the keyway to the bottom of the shaft, but what was this measurement? I got a piece of brown paper and borrowed a pencil and started in, while the cutter was running through the next shaft, and soon had it.



Measuring the Depth of a Keyway.

In the right triangle *C B D*, *C D* is the radius of the shaft, which is 9/16, or 0.5625 inch, and *C B* is half the width of the keyway which is 3/16, or 0.1875 inch. Find the side *B D* of the triangle.

$$(BD)^2 = (9/16)^2 - (3/16)^2$$
$$BD = 0.530 \text{ inch.}$$

Then subtract this from the radius *A D*,

$$0.5625 - 0.530 = 0.0325 \text{ inch} = AB.$$

Then the whole depth of the keyway from the top of the shaft is $AB + BF$, or

$$0.0325 + 0.15625 = 0.18875 \text{ inch} = AF.$$

Subtract *A F* from *A E* to get *F E*.

$$1.125 \text{ inch} - 0.18875 \text{ inch} = 0.93625 \text{ inch} = FE.$$

Then, when you want to cut the keyway, set the cutter touching the top of the shaft, and run up the table the distance $AF = 0.18875$ inch; and when you want to inspect the finished work, measure *F E* with the micrometer for the dimension 0.93625. C. E. BURNS.

Beverly, Mass.

THE COMPARATIVE STRENGTH OF SCREW THREADS.

C. Bert Padon.

There has been considerable discussion from time to time among mechanics with whom I have worked, as to which of the three forms of thread, V, square and Acme, is the strongest against shear. Having an opportunity during my junior year at the James Millikin University, Decatur, Ill., to do a little laboratory work, I undertook to settle this question with the idea of determining as nearly as possible with the means at hand just what relation these styles of thread bear to each other.

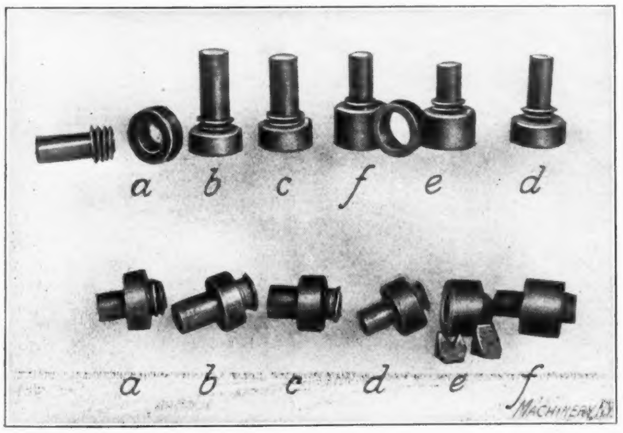
Each of the three forms was tested under two different conditions. First, a screw and nut of each form was made with threads all the same outside diameter, 15/16 inch, and with both screw and nut of the same axial length, 17/32 inch, and of the same material, the grade of steel commonly known in the shop as "machine steel." These three samples are shown at *a*, *b* and *c* in the photograph, in which *a* is the V-thread, *b* the Acme thread, and *c* the square thread. In the second test all three screws were of the same root diameter, about 5/8 inch, and were all made of gray cast iron, while the nuts were of machine steel. The length of the thread helix in each screw was such that each of the samples would present the same shearing area, the assumption being that they would shear at the root diameter of the screw since the screw was made of the weaker material. The different thicknesses of the nuts to suit the length of the helix required for this will be noticed in the halftone at *d*, *e*, and *f*, which show respectively the V-thread, Acme and square samples. All the threads were made a snug fit, with the threaded length of the screw exactly the same as the thickness of the nut. The diameter of the shank was less than the root diameter of the thread in each case. The screws were all 6-pitch.

In the cut the upper row shows the samples before testing, while the lower row shows the nature of the failure of each sample under test. A 50,000-pound Olsen machine was used. A nut was supported on the ring shown with sample *f* to allow room for the screw to drop through the nut when it failed, while pressure was applied at the top of the shank, which was carefully squared. The shank of the Acme thread screw *e* in the second set of three samples was not strong enough to withstand compression but crushed before the thread gave way, at a pressure of 29,300 pounds. The fragments of the broken shank are shown. The screw was afterwards pushed through with a short piece of steel rod, failing at 29,600 pounds pressure. The accompanying table gives the results of the test.

RESULTS FOR TESTS OF SHEARING STRENGTH OF SCREWS.

Sample.	Style of Thread.	Material.		Thickness of Nut.	Diameter of Screw.	Breaking Load in pounds.	Remarks.
		Screw.	Nut.				
			Threads same outside diameter and all 6 pitch.				
a	Sharp V	M. S.*	M. S.	17/32	15/16	29,980	Threads bent over in both screw and nut.
b	Acme	"	"	"	"	34,090	Sheared at root of screw.
c	Square	"	"	"	"	23,880	" " " " "
			Threads same root diameter, 5/8 inch, and same area of section to resist shear. All are 6 pitch.				
d	Sharp V	C. I.*	M. S.	1/2	.914	20,450	Sheared at root of screw.
e	Acme	"	"	13/16	.792	29,600	Shank crushed at 29,300 pounds, pushed through with steel rod and sheared at root of screw.
f	Square	"	"	1	.792	25,550	Sheared at root of screw.

* M. S. stands for Machinery Steel; C. I. for Cast Iron.



Test Pieces used for Finding the Comparative Strength of Screw Threads.

As will be seen from the above table, the Acme, or 29-degree thread, makes the best showing in each case. This has been an interesting experiment to me and I am sure it will prove of some value to at least one firm who was interested in the experiments, and who has adopted the Acme thread as a feature in the design of the machinery constructed in its shops.

C. Bert Padon.

Decatur, Ill.

[The V-thread sample, *a*, evidently could not have failed in the way described without expanding the nut enough to allow the distorted threads to slip by each other. In this case, then, the thickness and strength of the nut play an important part. If the hole had been tapped in a larger piece of metal, it is difficult to believe that the thread would have failed by shearing or in any other way at a pressure less than that sustained by the Acme thread.—Editor.]

C. Bert. Padon was born at Troy, Ill., December 17, 1870. Besides a common school education he has graduated from Brown's Business College, Decatur, Ill., has taken a correspondence course with the International Correspondence Schools, and is now completing his fourth year at the James Millikin University, Decatur, Ill. He served an apprenticeship as machinist with The Decatur Novelty Works and has since worked as a machinist for that firm and the H. Mueller Mfg. Co., of Decatur. He has also held for two years the position of assistant instructor in machine shop practice in the school he is at present attending. His specialty is experimental work.

ADJUSTABLE SCALE FOR LAYING OUT TABLE.

Among the suggestions received from a man engaged in the tool-room, was one for an adjustable scale for use in setting off vertical heights on the laying-out table, and as the idea seemed good, permission was given to him for making the device himself, according to his own ideas. Fig. 1 shows the tool as made. It consists of a cast iron base, *A*, a round slide *B*, carrying a 12-inch flat steel rule, *C*, adjusted for height by means of the screw *D*, slide and rule being clamped by means of the screw *E*. Its use can be best explained by an example: It is required to set out two lines on opposite faces of a casting, say 5 3/16 inches apart, the lower line being the center of a boss about four inches from the base. The center of the boss being obtained by means of dividers or other instruments, a height gage is adjusted to this center and a line marked across the face of the boss. The height gage is then trans-

ferred to the adjustable scale where it indicates, perhaps, about 4 3/64 inches. Now instead of adding 4 3/64 inches and 5 3/16 inches together, with the consequent risk of error, the scale is adjusted by means of the screw *D* until the 4-inch division is opposite the pointer on the height gage, and it is then an easy matter to add the 4-inch and 5 3/16-inch together, setting the height gage to 9 3/16 inches, this giving the distance apart required.

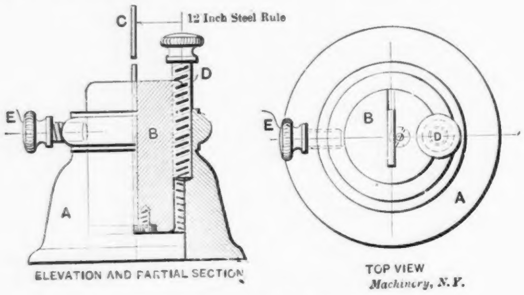


Fig. 1. Adjustable Scale for Laying Out Table.

Upon my accepting an appointment in another shop later, the need was observed there for something similar, and the above device was recalled, but although the idea was good, an improvement suggested itself to me, this being embodied in the scale shown in Fig. 2. In principle the device is the same but instead of the flat scale as originally used, a 12-inch triangular scale was substituted, the lower end of this resting on a projection at the foot of plunger *F*, this plunger being supported by the spring *G*. Adjustment of the scale is effected by means of the nut *H*, the spring keeping the upper end of the scale always against this. Two advantages of this later device are that readings can be taken much nearer the base, and the scale can be used for measuring against a face at times, without the assistance of a height gage.

The graduations on the triangular scale, which was a Brown & Sharpe No. 246, were No. 20, being fully divided along one edge of each face in 1/16, 1/64, and 1/100. It is an easy matter to remove the nut and change the scale to bring any of the divisions to the front.

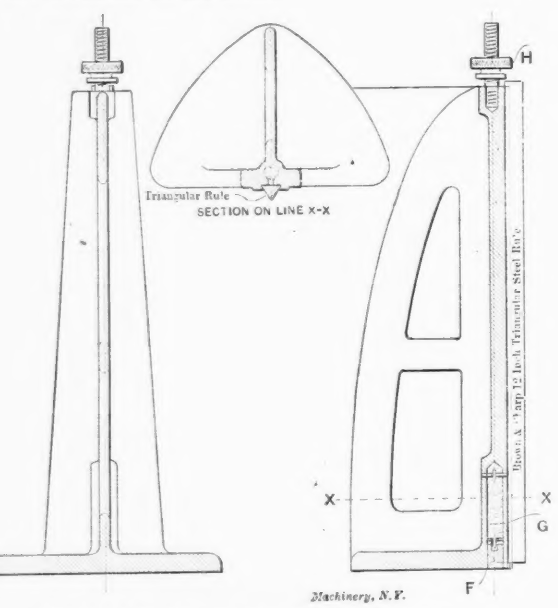


Fig. 2. Adjustable Scale for Laying Out Table.

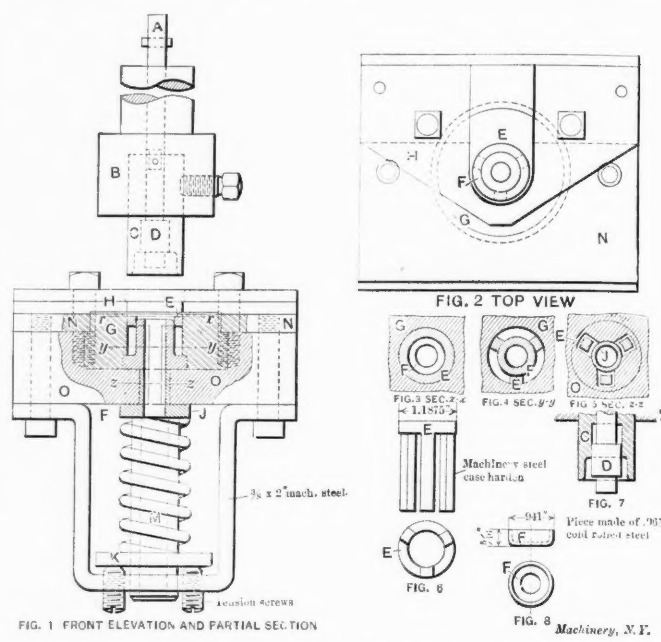
If the inventor of the original device should read this I hope he will forgive me for "pirating" his idea. I can certainly testify to its utility and I hope he will feel pleased that it has now been given publicity for others to copy or improve upon where not already known.

GEORGE D. HADUN.

MAKING A BALL-BEARING CUP IN A SINGLE ACTION PRESS.

Having a cup to make for a ball bearing which required rapid and cheap production of the parts, I designed the die shown herewith to produce the same on a single action press, as we have no double-action press.

The die block *O* is of mild steel, with a 3-inch round plug *G* set into the center, which plug is held down by the 3/8-inch plate *N*, shown in Fig. 1. Inside and concentric with this is a combined forming and piercing die *F*, projecting up to within 1/8 inch of the face of die *G*. Between the outer and inner die is a spring stripper pad, detailed in Fig. 6, which forces the finished cup into the punch as it recedes. This pad is held in the position shown by the thimble *J*, which is in turn supported by the stiff spring *M* bearing on washer *K* and the adjusting screws beneath it. The section views, Figs. 3, 4 and 5 make this construction clear. The back gage and scrap stripper *H* are cut away in the back, as shown in Fig. 2, so that as work falls out of the punch it will not catch on the die, but will slide off easily, being used on an inclined press. The upper die or punch consists of 1 3/16 inch blanking punch *C* with the inside formed to draw the sides of the cups and with a central punch *D* for piercing the center hole, which, by the way, does not need to be accurate in size.



When the ram descends, with the stocks in place, blanking punch *C*, in conjunction with die *G*, first cuts out a disk of the proper diameter. As the ram continues to descend, and blank and pad *E* are carried down against the resistance of spring *M* until die *F* is met, when the stock is drawn into the required cup shape. Continued movement punches the central hole through the action of punch *D* on die *F*. As the ram rises, spring *M* and pad *E* force the work into the punch *C*, from which it is ejected at the top of the stroke through the action of central punch *D*, as shown in Fig. 7. The work drops off from *D* readily, since the fact that it is drawn and punched simultaneously produces a hole about 1/64 inch greater than the diameter of the punch.

With this die we can produce from ten to twelve thousand of the cups in ten hours, with a boy running the press.

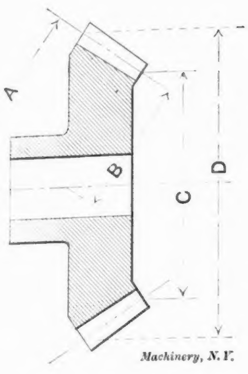
Aurora, Ill. CORWIN LAMOREAUX.

CUTTING BEVEL GEARS.

I have run across a way to cut bevel gears, which eliminates the guess work necessary in the ordinary "cut and try" method of milling them, in which two or three gears are bungled before the number of holes to turn the dividing head, and the amount to set the cross-slide off center is discovered.

Find the standard spur gear cutter for the large end in the usual manner, finding the pitch by dividing the number of teeth by *D*, and the number of teeth by which to select a cutter by multiplying twice *A* by this pitch. Find a cutter for the small end of the teeth in the same manner, using the measurements *C* and *B*.

Then run the cutter for the small end through one tooth at the right depth, which will give the correct shape of the tooth at the small end; also run in the cutter for the large end, set at correct depth, until it cuts its full depth. Then



CuttingBevel Gears.

take the cutter for the large end and set it so it will trim as near as possible to the sides of these two cuts. By this method you will know just where you are at, and can easily set your machine to cut as perfectly as possible. If you want a special gear for some job, which must be pretty near right, run the cutter for the small end through all the teeth and then you will have a correct surface to file to. C. E. Burns.

Beverly, Mass.

METHOD OF CUTTING LATHE LEAD SCREWS.

The annexed Fig. 1 shows a method I have used for cutting lathe lead screws which has worked out very well. As usual two cutting tools are used, one in front, right side up, and the other at the back, also right side up, to cut on the reverse trip. The cutting tools in this case were round, like short

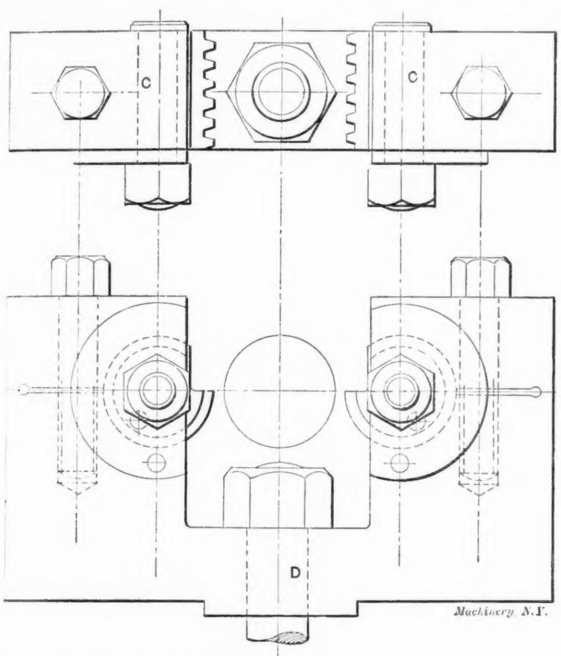


Fig. 1. Double Tool-post with Circular-formed Threading Tool.

sections of the screw to be cut but left-hand to cut a right-hand screw. They were cut with the thread on a taper and the outside turned straight so that the leading cutter tooth cut to the full depth that we could take at each traverse and the succeeding teeth widened the cut, only the last two usually cutting in the full side of the thread, as shown in Fig. 2.

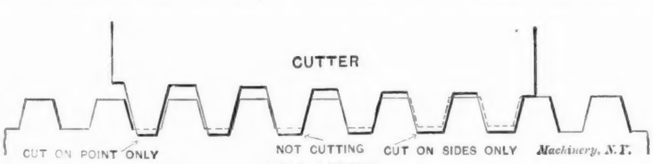


Fig. 2. Illustrating the Cutting Action of the Tools.

The limiting element in using this device became the torsion of strength of the screw we were cutting. We found on our 16-inch size that it was cheaper for us to use 1½-inch stock than 1¼-inch on average lengths just on this account because the time saved in cutting more than covered the increased cost of stock.

The bolts *C C* and their washers and nuts were an afterthought and helped to hold the cutters in place. The dowel pins had to be changed every few grindings. Bolt *D* held the device to the top of the cross slide, in place of the tool post.

Worcester, Mass. E. H. Fish.

THE CONGESTED CONDITION OF THE PATENT OFFICE.

Referring to the condition of the Patent Office at Washington, D. C., regarding the number of applications awaiting action, you will notice by reference to the accompanying statistics that on August 28, 1906, there were 23,811 cases awaiting their turn to be examined. You will also notice that the previous week showed that there were 23,523 cases, consequently the office got behind, in one week, of some 288 cases. This same condition has been partially true of some of the previous weeks, as you will note by reference to the table. Now, if we assume that the Patent Office is going to continue getting back from week to week (and we have every reason to so assume, judging from the table of figures), we can look for nearly 30,000 cases awaiting action by this time next year; this is figuring on the last week's gain of 288 cases.

1906.	Applications Awaiting Action.	Patents Granted.	1906.	Applications Awaiting Action.	Patents Granted.
Jan. 2	17,353	669	May 8	21,417	699
Jan. 9	17,256	659	May 15	21,414	670
Jan. 16	17,471	461	May 22	21,501	671
Jan. 23	17,752	521	May 29	21,507	646
Jan. 30	17,916	643	June 5	21,408	690
Feb. 6	17,891	655	June 12	21,612	614
Feb. 13	18,086	639	June 19	21,656	604
Feb. 20	18,007	611	June 26	21,813	621
Feb. 27	18,246	628	July 3	21,915	602
Mar. 6	18,860	645	July 10	21,958	603
Mar. 13	19,152	676	July 17	21,923	643
Mar. 20	19,192	627	July 24	23,022	649
Mar. 27	19,613	634	July 31	23,139	647
Apr. 3	19,958	606	Aug. 7	23,436	598
Apr. 10	20,263	605	Aug. 14	23,647	592
Apr. 17	20,609	671	Aug. 21	23,523	528
Apr. 24	20,846	640	Aug. 28	23,811	586
May 1	21,406	689			

At the present time most of the divisions which have such classes as automobile parts, machinery, tools, appliances and other divisions with kindred devices, are some eleven months in arrears on *new* work, or on work which has not been heretofore examined, while they are from three to six months behind on responses or amended work. Now, judging from the figures given above, is it not reasonable to believe that this time next year, we shall be waiting about eighteen months on new work and about eleven or twelve months on amended work? Now, what does this mean? It means in the first instance, industrial discouragement, as well as financial discouragement. The man who would invent will not do so unless he sees some immediate return for his labors and the man who would put up money will not do so in view of the fact that the inventor can not get his patent quick enough. Again, the Patent Office is going behind, the race of competition is going ahead—the results are obvious.

Over against this condition of affairs, there is a bank account to the credit of the United States Patent Office of nearly $7,000,000, and this fund is growing daily. Congress, it would seem, is the only power that can adjust these matters, and yet no one seems willing to take the matter up and push it to completion. Some two or three years ago the New York *Times* made some faint efforts toward rectifying the situation, but nothing came of it. I propose that some measure for relief be pressed at the coming session of Congress. Fred. W. Barnaclo.

New York.

ANOTHER ANSWER TO THE TANGENT CIRCLE PROBLEM.

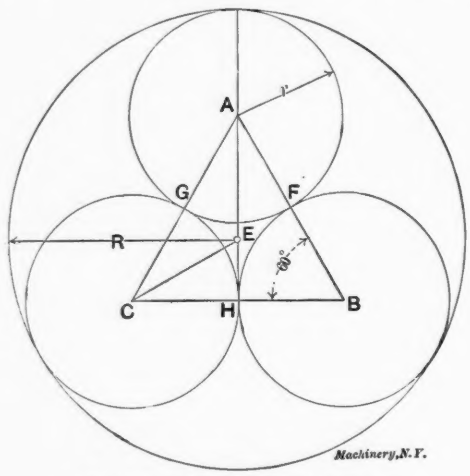
In the April issue of Machinery there appeared an article in the How and Why column discussing the method of finding the radii of three small tangent circles, tangent to and within a bounding circle. I present herewith a method of solving this problem by geometry alone and also show a way of finding the area of the figure *GFH* bounded by arcs of the three small circles. We will take the second of these problems first.

To find the area *GFH* within and bounded by the three tangent circles *ABC* when the given quantity is the radius of the small circle: Construct the triangle connecting the

centers of the circles at ABC. Then find the area of this triangle and subtract from it the area of the three sectors FGA, GHC, HFB. The angle of one sector is 60 degrees and the three together will be $3 \times 60 = 180$ degrees or ½ a circle. Hence if r is the radius of the small circle, the area of the desired figure will be equal to the area of the triangle ABC minus the area of a semi-circle with radius r. The area of the triangle $= \frac{1}{2}\, CB \times AH = HB \times AH$. But $AH = \sqrt{AB^2 - HB^2}$; now assuming that the radius of each small circle is unity or 1, the equation becomes $AH = \sqrt{2^2 - 1^2} = \sqrt{3} = 1.732$. The area of the half circle with a radius of unity or

$$1 = \frac{3.1416 \times 1^2}{2} = 1.5708.$$

Hence $1.732 - 1.5708 = 0.1612 =$ the required area, which multiplied by the square of any numerical value for radius r gives the area numerically. If, for instance, $r = 2.5$, the area of FGH will be $2.5^2 \times 0.1612 = 1.0075$ square inches.



Problem of Three Tangent Circles.

To find radius r when the radius R of the bounding circle is given: CEH and ACH are similar triangles. From this fact we get the proportion $CH : AH = EH : CH$, or $CH^2 = AH \times EH$. In the previous problem we found that when CH or $r = 1$, $AH = \sqrt{3}$. Substituting these values in the equation we have $1 = \sqrt{3} \times EH$, or $EH = \frac{1}{\sqrt{3}}$. Now $(AH - EH) + 1 = R$ when $r = 1$. Substituting numerical values for AH and EH, we have: $R = 2.1546$. Hence $r : R = 1 : 2.1546$.

$$\text{Therefore } r = \frac{1 \times R}{2.1546} = 0.464\, R.$$

From this it follows that if the radius of the large circle is known it is only necessary to multiply it by 0.464 to find the radius of the small circle.

Philadelphia, Pa. SAMUEL AROSON.

[In the answer to question No. 16, "How and Why," of the April, 1906, issue of MACHINERY, to which our correspondent refers, an error was made in the table given in the answer. The second and fourth columns should be headed r, and not $2r$, as they are given.—EDITOR.]

A WAY TO INDEX DATA SHEETS.

I show herewith a method of indexing my MACHINERY data sheets. The cut, I think, explains itself, since it is a copy of part of my own index. As will be seen, the data sheets are published, and each one is given a page number in the file which is entered opposite the title in the index. Wherever there is more than one table to a page they are entered separately, as shown for page 102, for instance. The right-hand side of the index is ruled vertically, one for each letter of the alphabet. In these columns crosses are placed to indicate the leading words in the title or subject of the data sheet referred to; for instance, page 110, Table of Gib Keys has a cross under B for "Buffum," the contributor of the table, under G for "gib," under K for "key," and under T for "table." In looking for this particular sheet, if the reader has the word "gib" in his mind, he will follow down the column G, glancing at each title which has a cross opposite it in this column until the right one is reached, which will be done in less time than it takes to describe the operation. JOHN ROE.

Philadelphia, Pa.

PAGE NO.	DESCRIPTION	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
101	WEIGHT OF ROLLED SHEET METALS													X					X	X				X			
102	WEIGHT OF SUPERFICIAL FOOT OF CAST IRON			X						X														X			
"	WEIGHT OF NUTS & BOLT HEADS IN POUNDS		X												X									X			
"	SPECIFIC GRAVITY & WEIGHT OF METALS													X						X				X			
103	WEIGHT & AREA OF COLD ROLLED STEEL SHAFTING	X		X																X				X			
104	APPROXIMATE WEIGHT PER IN. FACE CAST IRON GEARS							X																X			
105	PIPES & PIPE FITTINGS (PAPER BY J. B. BERRYMAN)		X				X										X										
106&107	WHITWORTH'S STANDARD SCREW THREAD FOR BOLTS		X																	X	X			X			
108	WHITWORTH'S SCREW THREAD FOR GAS & WATER PIPE																X			X	X			X			
109	PROPORTIONS FOR PLAIN BEARINGS (CHILDS)		X	X													X										
109	PROPORTIONS FOR WRENCHES (CHILDS)			X													X							X			
110	TABLE OF GIB KEYS (F. D. BUFFUM)		X					X				X									X						
111	PROPORTIONS FOR COLLARS (G. W. CHILDS)			X													X										
"	PROPORTIONS FOR HAND WHEELS (G. W. CHILDS)			X					X								X							X			
112	PROPORTIONS FOR PLATE COUPLINGS (G. W. CHILDS)			X													X										
"	PROPORTIONS FOR FLANGES (G. W. CHILDS)			X			X										X										
113	DIAGRAM OF JOURNAL FRICTION (R. A. GREENE)				X		X	X			X																
114	DIAGRAM OF CHAIN FRICTION (R. A. GREENE)			X	X		X	X																			
115	STANDARD DRUM SCORES (R. A. GREENE)				X			X												X							
116	STANDARD SOFT STEEL ROPE SOCKETS WITH PIN																		X	X							
117	COMPARISON OF MONEY STANDARDS			X										X						X							

Method of Indexing Data Sheets.

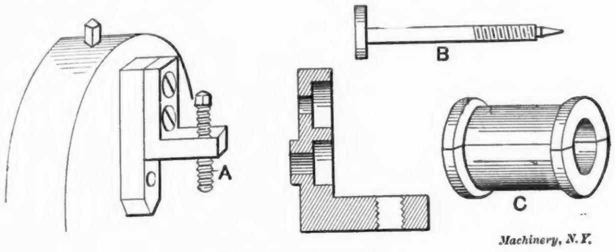
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

CHUCK JAW.

The sketch herewith is of a jaw for the lathe chuck, to take the place of the removable piece of the chuck jaw on some work, mostly repair jobs. As a chuck wears, the jaws spring outward, and the inner end of the jaws grip the piece long before the outer end, and the more the jaws are tightened the more this difference is exaggerated. The outward end of a long piece is sure to wobble and it is almost impossible to get it true, and then to keep it so. The attachment



A Handy Chuck Jaw.

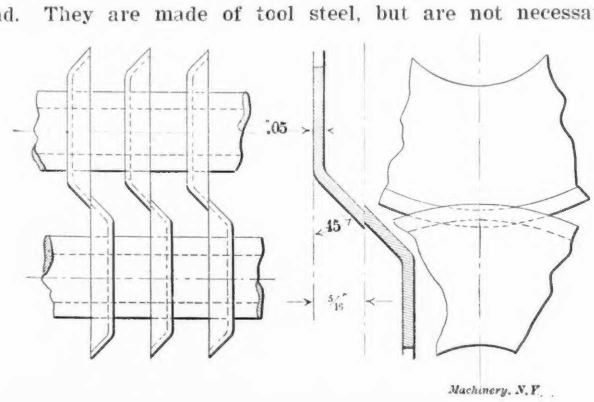
as shown in the sketch is designed to prevent this trouble. Supposing you are going to use a drill in the chuck and you want it to run true; adjust the rear end central with the jaws, then adjust the setscrews *A*, until the outer end runs true, and there you have it. If a piece of rod not long enough for the center rest, is to be turned or threaded, and the stock must run true, or if it is a finished piece, as a stud with the thread stripped, and which is not centered, this jaw will be very handy. On pieces such as the valve stem, *B*, which is to be repointed, or the bushing, *C*, which is to be babbitted and rebored, this jaw will be invaluable, as they must run very true. The surface by which they may be gripped is narrow and offers an insecure hold, and they are too fragile to allow of clamping very tightly. The device is handy for other similar pieces which have to be gripped at two places of different diameters. C. E. Burns.

Beverly, Mass.

DESIGN OF PAPER SLITTING CUTTERS.

A form of paper slitting cutters is here shown which has advantages that the usual styles do not possess, and therefore may be of interest.

They consist of a sheet steel stamping 0.05 inch thick and are so placed upon their arbors that they are always kept sharp by the cutting edges rubbing together. As the edges wear, the arbors are adjusted by a suitable means at each end. They are made of tool steel, but are not necessarily

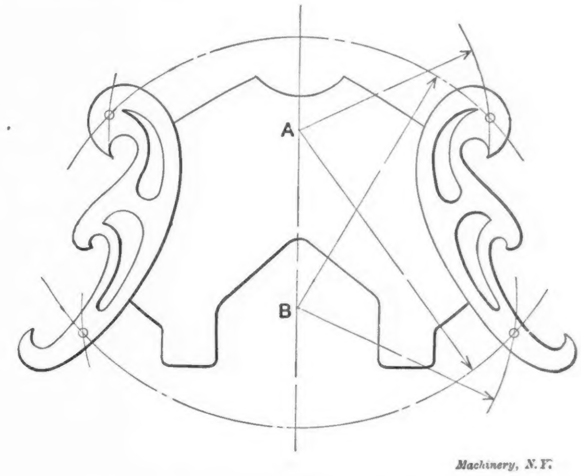


A Satisfactory Form of Paper Slitting Cutter.

hardened. Each set is placed on its arbor with the desired distance pieces between them, and the arbors placed in position on the machine in which they are to run. The machine is started up and the cutters grind each other. End movement for each arbor is provided to allow each set to come into contact. By this means it is evident that the cutters will run true and will need no further grinding, and will cut until they are worn out, which in some cases has been over a year, although running every working day. Winamac.

TO DRAW SYMMETRICAL REVERSE CURVES.

In drawing a symmetrical figure which requires a right and left curved line some difficulty may be experienced, especially if a celluloid curve is used. By using a wooden curve, marks can be put on it to indicate the beginning and ending of the line desired, but doing this for some time puts the curve in a bad shape and it becomes hard to discern which mark was put down last. It is hard to put marks on the rubber or celluloid curves, so the following method of using curves of any material seems to be ideal:



Method of Drawing Symmetrical Reverse Curves.

As can be seen in the cut, there is a hole about 1-16 inch diameter put in each end of the curve. In use, the curve is laid on the drawing, the location of the holes marked with pencil point, and the desired curve drawn. On the center line of the piece to be drawn select two centers, as *A* and *B*, and from them locate the positions of the holes on the opposite side. Place the holes in the curve over these points and the curve is in the reversed position. The method is simple; in fact, it takes a much longer time to explain it than to follow it. Winamac.

CHUCKING PIECES FOR PLANER WORK.

The two chucking pieces for holding thin pieces on planers, shown by A. Fr. Bierbach in a recent number are very neat and useful, and are on the same general principle as those shown on page 155 of my "Work Shop Hints." I would suggest, however, instead of having two sets, one for through slots and another for so-called dovetail grooves, as shown by

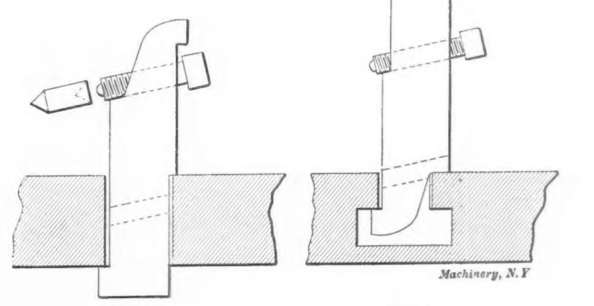


Fig. 1. Fig. 2

Mr. Bierbach, combining the features of the two kinds in one double-ended device as shown herewith. Fig. 1 illustrates its use on a through slot and Fig. 2 the same device turned upside down for use with a dovetail groove. The screw-holes are to be drilled and tapped before the steps are planed in the pieces. Robert Grimshaw.

Hanover, Germany.

* * *

The copper production of the world amounted to more than 700,000 tons during 1905. The United States produced more than half, or exactly stated, 58 per cent of the total amount. Next to the United States comes Mexico as the largest producer of this metal.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas. It makes no difference if they are old and supposedly well-known, provided they have not already appeared in this department.

240. CEMENT FOR LEATHER BELTS.

To make a cement for leather belts use gutta percha, 16 parts, pure white India rubber, 4 parts; dissolve, and then add pitch, 2 parts; shellac, 1 part; and boiled linseed oil, 2 parts. W. R. BOWERS.

Birmingham, Eng.

241. CEMENT FOR FASTENING GLASS WORK TO BRASS TUBES.

A cement for fastening glass work to brass tubes is made of rosin, 5 ounces; beeswax, 1 ounce, and red ochre or Venetian red, in powder, 1 ounce. W. R. BOWERS.

Birmingham, Eng.

242. SOLDER FOR SMALL PARTS.

To make a solder for small metal articles cut tinfoil into the shape wanted and wet on both sides with sal-ammoniac. Have the surface of the piece clean, place on it the wet tin-foil and then press the parts together firmly and heat until the tin-foil is melted. E. W. NORTON.

243. MIXTURE FOR EBONIZING WOOD HANDLES, ETC.

To prepare a mixture for ebonizing wood handles, etc., use logwood, 2 pounds; tannic acid, 1 pound, and sulphate of iron, 1 pound. Apply hot and polish when the pieces have become dry and cold. W. R. BOWERS.

Birmingham, Eng.

244. TO PREVENT SCALE IN HARDENING FINE DIES.

It is possible to prevent the formation of any scale in the impression of fine jewelers' dies and the like, and retain the finished brilliancy of surface, by applying a mixture of powdered ivory black and sperm oil, mixed to the consistency of paste. It is only necessary to apply a thin coat.

HARDENER.

245. TO CUT CORK.

In cutting cork, the knife is to be kept greased. Where, however, the desired piece is symmetrical about one axis, and of circular cross-section, it may best be roughed with a greasy knife and then ground to profile with a coarse emery wheel. Cork pen-holders are made in this way. Where many pieces are to be cut out of sheet cork, it is advisable to use a band knife, against which there is kept pressed a block of grease.

Hanover, Germany. ROBERT GRIMSHAW.

246. ARTIFICIAL SKIN FOR BURNS, ETC.

Dissolve equal parts of gun cotton and Venice turpentine in 20 parts sulphuric ether, dissolving the cotton first and then the turpentine. Keep in a tightly corked bottle. The use of the turpentine is to prevent pressure or pinching of the flesh caused by the evaporation of the ether when applied. Water does not affect this covering, hence its value for burns on the face or hands. E. W. NORTON.

247. PLASTER OR SALVE FOR USE IN PLACE OF STITCHES.

To make a plaster or salve which can be used in case of accident in place of stitches where a person has sustained a deep cut, melt together white rosin, 7 ounces; beeswax, ½ ounce; mutton tallow, ½ ounce. Pour into cold water and work with the hands until it is thoroughly incorporated, and roll out into suitable sticks for use. When required warm and spread upon a firm piece of cloth, cutting the wax into narrow strips in case of deep wounds. It will be found to hold the edges of the flesh firmly together.

E. W. NORTON.

248. TO HARDEN FINE DIES.

To successfully harden dies for fine work, such as are used by jewelers and others, be careful to have the surface free from all grease or oil, pack face downward in a mixture of equal parts of finely powdered hardwood charcoal and charred bone. Dip in salt water and draw temper to 450 degrees F.

HARDENER.

249. TO PREPARE TRIPOLI OR EMERY CAKE.

Tripoli, emery cake and crocus are all made in practically the same manner, the change being made in the composition when it is desired to have the composition more greasy. Melt tallow and paraffine wax or beeswax together. Beeswax is by far the best, but the cost of the same has led to the use of paraffine, which in many cases will work equally as well. After the tallow and wax are thoroughly melted, add tripoli or emery, whichever is to be made, a little at a time and stir in well, until it is as thick as is possible to make it; then pour out into a large tin, or better still into the moulds made for the purpose, and allow to cool.

Bridgeport, Conn. J. L. LUCAS.

250. TO CASEHARDEN A PIECE LOCALLY.

To caseharden part of a piece to a line or in a spot cover the part or surface to be hardened with a moderately heavy coat of black japan enamel. I prefer this as it bakes on more closely than anything else. Clean the work thoroughly, then put on a heavy coat of copper and the work is now ready to be carbonized, and is packed in a pot in bone or leather in the usual manner. Heat long enough to give the required depth of "case." Then take out of the fire and cool down in the pot. When cold reheat and dip in oil or water. The copper blocks the absorption of carbon while the japan burns off and allows the carbon in the bone or leather to be absorbed by the iron. E. W. NORTON.

251. TO TONE BLUEPRINTS.

After washing the blueprint in the usual manner immerse it for a half minute or less in a solution made by dissolving a teaspoonful of potassium bromide crystals in one-half gallon clear water. Then rinse the print in clear water and hang it up to dry. A galvanized iron or japanned tray may be used for the solution. Prints may be much overprinted and yet give beautiful clear whites and extremely deep blues, easily seen by the workman and a delight to the directors, the latter especially because the solution is quite inexpensive, and can be used over and over again until an objectionable precipitate forms. I have used this toning with Kueffel & Esser's paper and also with a number of local brands of blueprinting paper, all of which gave such fine results that we specify "all blueprints must be toned." F. J. SCHAUFELBERGER.

Denver, Col.

252. TO RECUT OLD FILES.

Brush the old files with a wire brush, put them in a tub, cover them with water and add 6 ounces of caustic soda per each 100 files. In about two hours brush them again. They will then be free of grease and metal. Then put them in a box, lined with sheet lead, on a wire stand made for the purpose, and in such a way that they will not touch one another. Cover them with a solution made of nitric acid and water, one pint of acid to each gallon of water. In 25 minutes remove them, wash them in water, brush them with a hair brush and put them back in the liquid to which one more pint of nitric acid to each gallon of water has been added. In about 50 minutes remove them again, brush them after washing them with water and put them back in the liquid to which has been added ½ pint of sulphuric acid per each gallon of water. In 15 minutes remove them; wash them first in water, then in concentrated lime water till all trace of the acid has disappeared. When dry they will have the appearance and cutting quality of new files. I used this method for recutting old files long ago and found it O. K., and so can recommend it. J. M. MENEGUS.

Los Angeles, Cal.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

23. F. O. B.—Why is it desirable to tin the interior of a box before pouring babbitt?

A.—Tinning a box is done so that the babbitt will adhere to it. Babbitt poured into a box without preliminary tinning will not amalgamate with the metal so as to form a permanent connection, even if hot, but by tinning the interior surface of the box the babbitt adheres as its heat is sufficient to melt the tin and permit amalgamation. Tinning, of course, is done with a suitable flux, usually chloride of zinc; and the use of a flux is not feasible when babbitting. Coating a box with tin is analogous to the use of cement.

24. P. T. & S. Co.—What is the cheapest, best and quickest process for straightening steel plates, varying in thickness from ½ inch to ¾ inch, and varying in dimensions from 18 x 24 inches to 24 x 36 inches? These plates are not curved, but are slightly kinked, and must be reduced to practically a flat surface without being tooled, as a corrugated milling cut is to be taken across them.

A.—Probably the best method of straightening plates in a kinked or buckled condition is to run them between heavy rolls. In the absence of these the next best thing to do would be to pass them to a blacksmith shop equipped with a steam hammer and a surface-plate. A careful blacksmith with a heavy steam hammer having dies in good condition should be able to straighten the plates so that they would lie on the surface-plate with a variation of not more than 1/32 inch from a true plane. The question is submitted to our readers, some of whom may be able to give our correspondent the benefit of practical experience on a similar job.

25. A. D. T.—Starting with none why is it necessary to make three surface plates in order to get one?

A.—It is necessary to make three plates for the reason that two plates cannot be depended on to correct one another's inaccuracies. For example, one plate might be high in the center and another low in the center, in which case an apparently perfect bearing might be obtained and still neither surface be a true plane. By having a third plate such a condition would be readily detected for it is impossible for the third plate to match *both* of the others. Given plates Nos. 1, 2 and 3, Nos. 1 and 2 are fitted together, and Nos. 1 and 3. Now, at this point all three may be out of the true plane and still match, but the moment that plates Nos. 2 and 3 are put together the inaccuracy will be apparent. If both are low in the center, as would be the case if fitted to No. 1 high in the center, they both must be scraped down an equal amount until a bearing is secured. Then No. 1 is corrected by fitting to both No. 2 and No. 3, and so on. In this way three perfect surface plates are necessarily produced in order to get one.

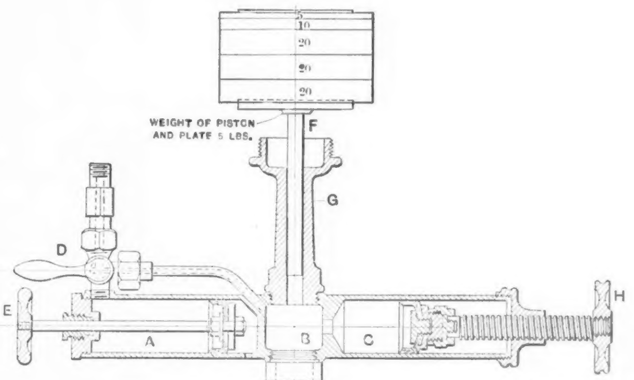
26. H. W. B.—An engine cylinder has six studs in the end and six nuts holding down the head; the nuts are tightened to a pressure equivalent to say 50 pounds per square inch, directly against the head of the cylinder. If steam is turned into the cylinder to a pressure of say 40 pounds per square inch, will there be a greater strain on the nuts with steam pressure in the cylinder than without?

A.—This is a question about which there has been a great deal of controversy. Broadly, for the case you specify, the admission of steam pressure into the cylinder would not increase the stress on the bolts. Suppose that a short section of spiral springs was placed under each of the six nuts and they were screwed down so that each spring pressed against the cylinder head with a pressure equivalent to 50 pounds per square inch on the sector of the head supported. Now, it is clear that the head cannot be pushed away from the end of the cylinder until the total pressure due to the springs is exceeded. Suppose, for clearness, that the diameter exposed to steam pressure is 6 inches; then the area exposed to steam pressure is 28.27 square inches and the total load imposed by the springs will be 1,413.5 pounds. The counter-pressure due to the steam pressure is 970.8 pounds; therefore the given steam pressure, or any internal pressure less than 1413.5 pounds could make no difference in the stress on the bolts. However, the foregoing answer applies only when the elasticity of the materials in compression is neglected. Suppose, for example, a perfectly elastic gasket is used between the cylinder head and the cylinder; then the internal pressure is added to the stress already existing in the bolts due to the compression of the gasket. Therefore, as cast iron and all materials are somewhat elastic it is evident that the broad answer given is not strictly correct, for the internal pressure does, in theory, add somewhat to the load on the bolts. The amount of additional loading depends upon the relative elasticity of the bolts and the surfaces in compression. If the bolts are long the amount of additional loading imposed on them due to the compression of the cast iron surfaces will be comparatively small.

* * *

A DEAD WEIGHT PRESSURE GAGE TESTER.

The American Steam Gauge and Valve Company have placed upon the market a testing apparatus for testing steam and other pressure gages which is reliable at all times owing to the fact that the pressure impressed upon the gage is obtained by weights. This apparatus is shown in sectional elevation in the cut. Its operation is as follows: The chambers *A*, *B*, *C*, are filled with a light oil, the gage to be tested is connected with the pipe leading up from the three-way cock *D*. This cock is then turned so as to connect *A* with *B*, and



Testing Apparatus for Pressure Gages.

handle *E* is pulled out so as to force oil from *A* into *B*, and into the gage, until the latter shows that there is some pressure acting upon it. Handle *D* is then turned to cut out cylinder *A*, weights are placed upon *F*, and handle *H* is forced in until piston *F* is lifted. If the gage registers correctly, its reading will agree with the weights on *F* + five pounds, this being the weight balanced by the piston *F* and its cap. To eliminate any error that may arise through the friction of *F*, the handle *H* can be moved in far enough to lift the weights some distance, and then it can be drawn out and the two readings thus obtained can be compared.

* * *

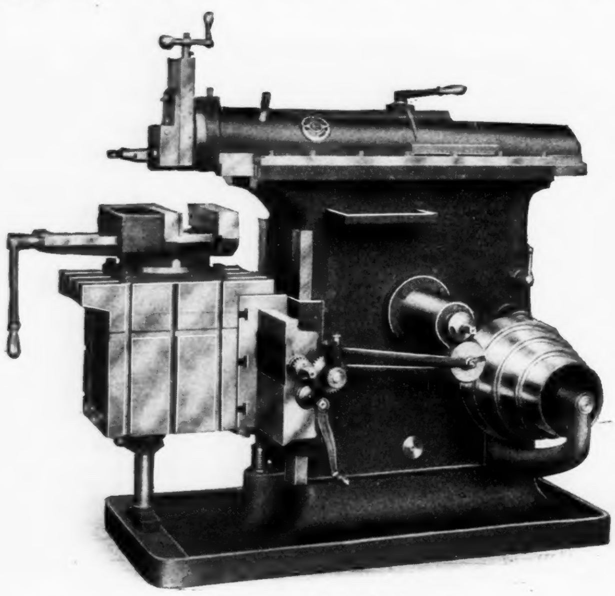
Some time ago we published a kink in regard to making typewriter copy from which clear blueprints can be taken. This is done by placing under the typewriter paper a sheet of carbon paper with the carbon side up so that in writing an impression will be made on the under side of the paper by the carbon, thus producing printing on both sides of the sheet. Blueprints from copy written in this way come out very distinctly and clearly. We have received a letter from Kearney and Trecker, Milwaukee, Wis., also explaining this method, but stating that in their practice it is used for much of the lettering on drawings, which are on bond paper. A typewriter with a wide carriage is employed for writing on the sheets. Much time is thus saved and the drawings have a neat appearance. It will take only a few minutes of any draftsman's time to try this as an experiment and it is believed the system will prove useful in any drawing office.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

TWENTY-INCH ROCKFORD SHAPER.

The Rockford Machine Tool Co., Rockford, Ill., whose 16-inch crank shaper was illustrated in the New Tools column of the November, 1905, issue of MACHINERY, have placed a 20-inch shaper of similar design on the market. This is shown in the accompanying halftone. Among the special features of this make of shaper are a strongly reinforced column, an improved vise in which the screw pulls the jaws together instead of pushing them, a high back gear ratio, and the use of high-carbon steel, ground to size, for all the shafting. The base is of pan construction for catching all the chips, dirt, etc., and has a forward extension for table support. The feed rod adjusts itself to any height of the table and does not have to be changed when altering the vertical adjustment. The actual length of the stroke is 22 inches, the horizontal travel of the table 25 inches, and the vertical adjustment of table 14⅝ inches. The machine has a key-seating capacity of 3½ inches diameter, and the net weight of the machine and countershaft is 2,800 pounds. Further details of this design will be found by referring to the description in the November issue, previously mentioned.



Twenty-inch Rockford Shaper.

NORTON CAR-WHEEL GRINDER.

The accompanying cuts show the general construction of a new car wheel grinding machine recently brought out by the Norton Grinding Co., Worcester, Mass.

The car wheels with their axle are driven by a worm and wormwheel near the center of the machine. The wormwheel is provided with a removable segment, and an opening is left in its journal in order to permit the axle to be placed in position. In order to eliminate the necessity of re-turning or re-grinding the journals and also for securing greater rigidity, the wheels revolve on their own journals. These rest at each end in half bearings of lumen bronze which are hemispherical on the external surface, and rest in hemispherical pockets. This latter arrangement permits a slight adjustment for worn wheel journals. In order to make further allowance for variations due to wear in the journals, the bottom of the bronze bearing is cut away, leaving only a small circular bearing at each side, which will act practically as a V-bearing. The journals are oiled automatically as they revolve by means of felt which is placed in the cut away portion of the bearing and saturated with oil. The stands carrying the bearings for the journals are movable in the longitudinal direction of the machine, thus being equally adapted for the support of axles with the journals inside or outside of the wheels.

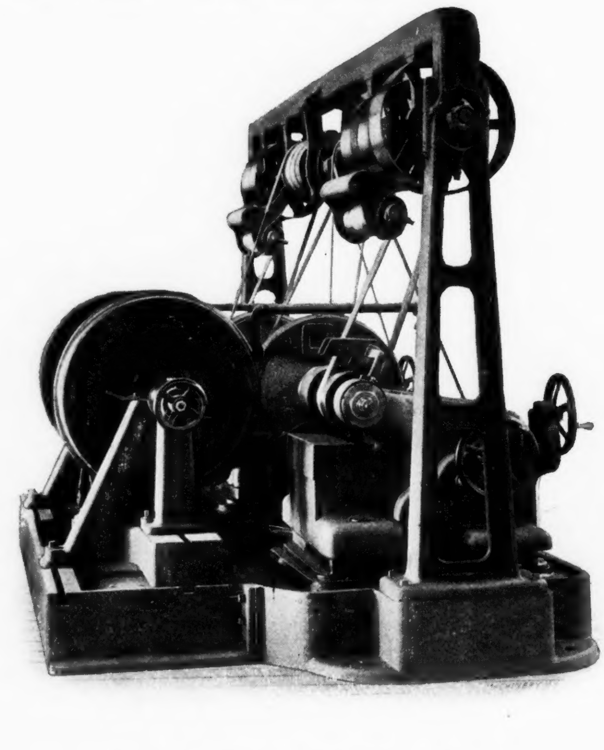


Fig. 2. End View of Norton Car Wheel Grinder.

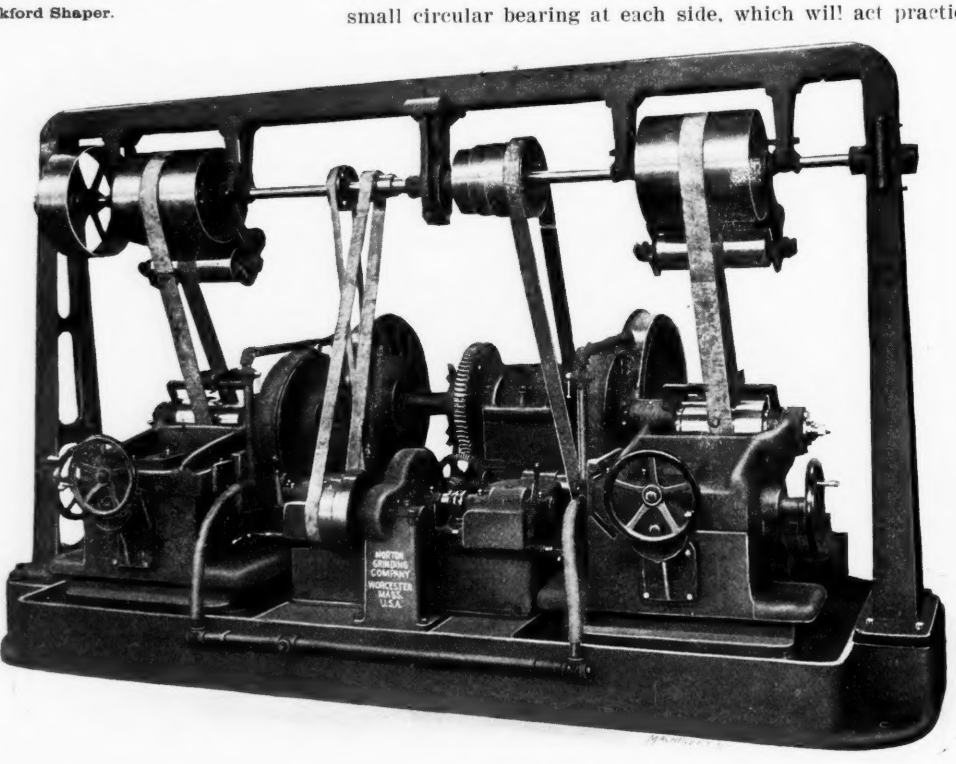


Fig. 1. Rear View of Norton Car Wheel Grinder.

The grinding wheels are 24 incnes diameter, with a 2¾-inch face. They are mounted on wheel slides similar to those on regular grinding machines. The wheel slide is mounted on a slide moving parallel with the face of the car wheel, and this slide in turn is placed on a slide base which is pivoted to the bed of the machine, and permits the setting of the grinding wheel to the different angles required.

The slide moving parallel with the car wheel face is provided with automatic feed. It can also be moved for short distances by a handwheel. A special oiling arrangement is provided for this slide which will operate without attention for long periods. By means of clutches, one of which can be seen in the rear view of the machine, the slide can be moved, and by raising the handles shown in the same view near the water hose, the slide will be brought to stop automatically when in its extreme position toward the flange of the car wheel. This will prevent cutting into the car wheel flange after having thrown the clutch, provided the wheel was adjusted properly in relation to the flange before throwing in the clutch. At the same time, the operator cannot stop the traverse feed in any other position than the one indicated by the automatic sto

The stopping and starting of the motion of the car wheels is accomplished by means of a lever between the wheels. The arrangement here permits, of course, the stopping of the worm wheel at the exact position, where, by means of removing the section referred to above, the axle can be put in place.

The machine has provision for water, and the base is so designed that all water is conducted to a removable settling tank. The supply is kept in a large water tank in the foundation under the machine, whence the pump distributes it to the wheels.

The overhead work is self-containing in order to permit a crane to pass over the machine for the purpose of placing the carwheel axles in, and removing them from, their bearings. The machine is furnished belted as shown in the cuts, and can be driven either from the lineshafts or by a motor. The latter should be a 30-horsepower motor of constant speed, and is shown in place in Fig. 3.

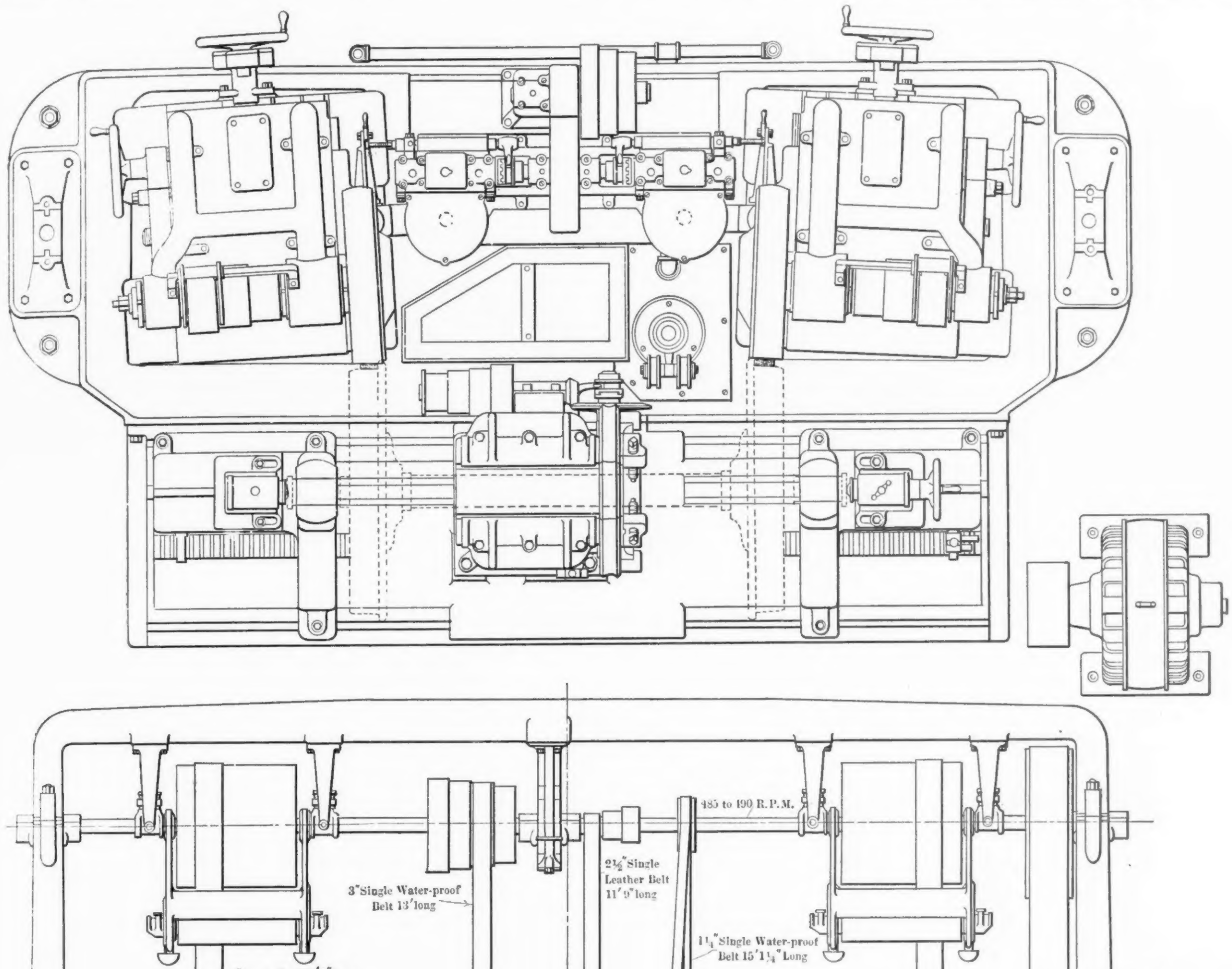


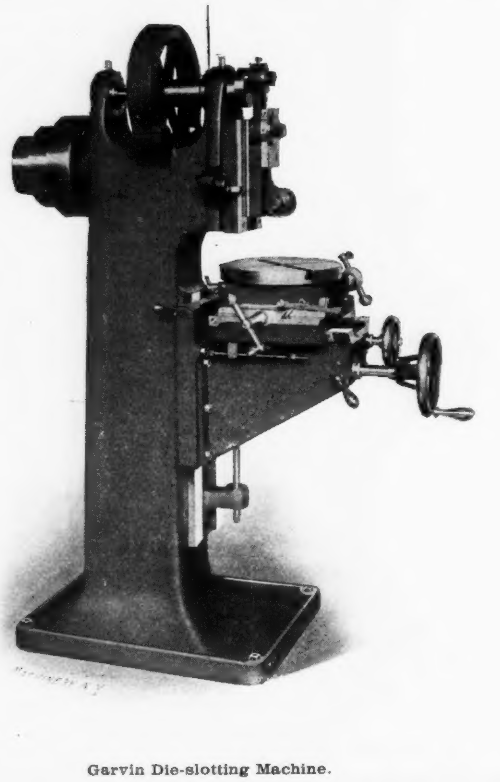
Fig. 3. Plan and Elevation of Norton Car Wheel Grinder.

While car wheels have been ground in the past, the machines and devices used have been such as to produce far from accurate results. The present machine, however, is designed with the view of obtaining commercially accurate results, and will grind car wheels within a limit of 0.002 or 0.003 inch as far as roundness and concentricity is concerned. The machine is particularly rigid and weighs 30,800 pounds.

GARVIN DIE-SLOTTING MACHINE.

The Garvin Machine Co., Spring and Varick Sts., New York City, have rebuilt throughout from newly designed patterns the die-slotting machine which is one of the firm's oldest products. Among the changes introduced is the adoption of a solid extended type of knee similar to that used on the builder's line of milling machines. Hand wheels are provided to control the elevating and lowering of the knee and the in-and-out movements of the slide instead of the ball cranks formerly used, these wheels being provided with micrometer dials for reading the adjustments. Stops are also provided for the motion of the table and the slide.

The handle for the rotary table is arranged to use dials for dividing purposes, but for small divisions and rapid work the table can be revolved by hand, using the lock pin device, which gives twelve divisions. The ram is driven from a cone pulley through a reducing gear and has a fixed stroke of 2½ inches, which has been found suitable for the class of work generally performed on this machine; this allows a stronger pin construction than is possible when this part is made adjustable. The ram and the slide in which it is contained are adjustable 5 degrees either side of the vertical, the setting being read from a graduated index. The tool block is of a special shape well suited for holding special tools. It swivels on a



Garvin Die-slotting Machine.

center suitably located to give the proper action, and is rocked by a cam on the lower end of the connecting rod which locks the slide on the downward stroke, and relieves the tool on the upward movement. This machine, which weighs 1,150 pounds, is well adapted to the usual run of slotting, such as small straight or taper key seating, punch and die work, internal or external gear patterns, especially where draft is required; where intricate outlines have to be followed, the combination of the two cross motions and the rotary table provide means for doing almost any work of this character.

GORTON DOUBLE DISK GRINDER.

The Diamond Machine Co., Providence, R. I., who build the Gorton line of disk grinders, have recently added to that line the double disk machine shown in Figs. 1 and 2. The machine is built with two heads, one solid with the bed and the other mounted on the slide in such a way that the distance between their faces is adjustable to suit different widths of work, which may thus be finished on both sides to accurate dimensions.

This machine, which is known as the "6 K Gorton," is regularly furnished with 18-inch steel disks. That on the right-hand head is mounted on a spindle which can be given end motion by means of the handle at the extreme right of the machine. A micrometer stop is provided, reading to 0.001 inch, thus permitting work to be duplicated within very narrow limits. The bearings in which this spindle slides are especially designed to exclude all dirt and emery dust. Not

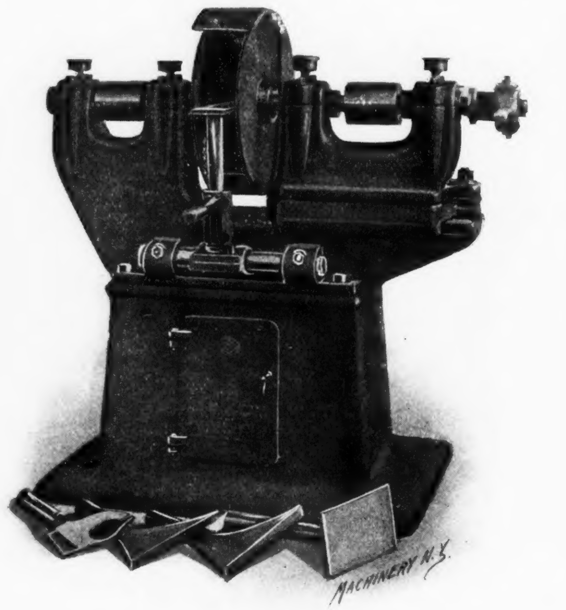


Fig. 1. Gorton Double Disk Grinder.

only is this head adjustable lengthwise of the bed for position, but it may be swiveled as well for any angle up to 10 degrees, so that tapering pieces may be ground as well as straight ones. When the removal of a large amount of stock is desired, emery rings, as shown on the floor at the right of the machine in Fig. 2, are used in place of the disks. Chucks for these rings are furnished at a slight extra cost.

The work is supported between the wheels by a table. These tables, of which a number are shown on the floor at the base of the machine in Fig. 1, are of varying widths to suit various sizes of work. The one at the extreme left is designed to hold thin circular pieces which may thus be finished on both sides at once. The bracket on which these tables are mounted, is

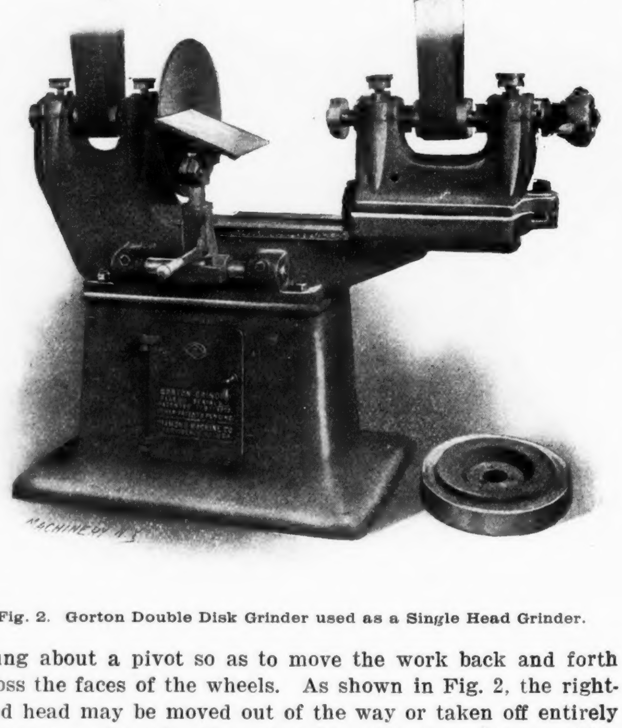


Fig. 2. Gorton Double Disk Grinder used as a Single Head Grinder.

swung about a pivot so as to move the work back and forth across the faces of the wheels. As shown in Fig. 2, the right-hand head may be moved out of the way or taken off entirely if desired, so, by using the adjustable table shown, the machine becomes for all practical purposes a single-head grinder of the usual type. Gages, studs, or jigs for holding irregular-shaped

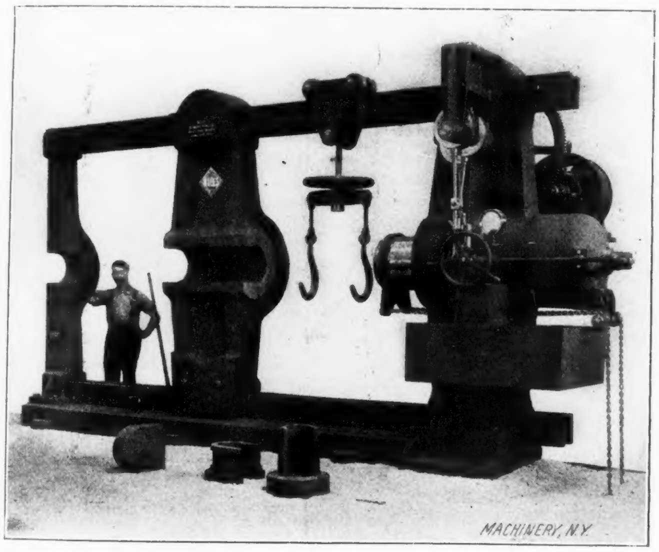
pieces may be fastened to the tables, thus greatly extending the range and rapidity of action of the machine.

The accessories furnished regularly with each machine are four 18-inch steel disks, six disk bolts and nuts, twelve assorted abrasive circles, one gallon of cement, one cementing press, three steel wrenches, four work tables, one adjustable table, one circular work table, and a double countershaft. The net weight with the accessories described above is 2,000 pounds. The machine will also be furnished with pedals in addition to the handles for operating the feeding movements when desired.

NINETY-INCH NILES 600-TON HYDRAULIC WHEEL PRESS.

The increase in weight of locomotives within the past few years has made changes necessary in railway repair shop equipment. This applies particularly to the hydraulic wheel press. Until very recently a hydraulic wheel press of more than 400 tons capacity had not been known, the usual equipment being of 300 tons capacity. Consequently many railway shops had found great difficulty in removing large locomotive drivers from their axles, especially in the case of steel centers with the tires in place. A wheel center forced on with a pressure of say 150 tons grips the axle with a greatly increased force when the tire has been shrunk in place. Often with the old equipment it has been necessary to remove the tires or to drill the hub in order to start the wheel center.

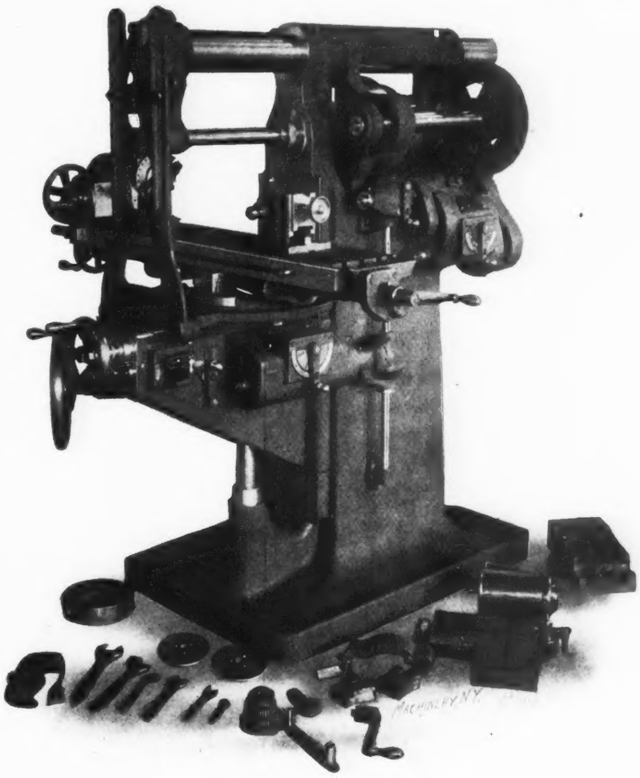
The accompanying illustration shows a 600-ton hydraulic wheel press recently placed on the market by the Niles-Bement-Pond Co. of New York. The distance between the ram and the resistance post is 8 feet 3 inches. The resistance post and the cylinder (which is one piece with its column) are steel castings. The outside diameter of the cylinder is 27 inches. Four tension bars are used to connect the two columns, and the resistance post is so arranged that its weight is entirely carried on the base-plate. The base-plate on which the press is mounted serves only to carry the weight, there being no stress transmitted to it since all pressure is taken by the tension bars. The cylinder is bored and lined with copper, expanded into place and burnished. The piston is packed with a cup leather in the usual form; it is counterweighted for quick return when the release valve is opened. A safety valve is provided which can be set to open at any desired pressure and is protected from tampering by a lock box. The pressure gage is graduated for tons of pressure and for pounds per square inch on the ram. The water tank is bolted to the post under the cylinder and takes the discharge and supplies the pump. The pump has three cylinders, the pistons of which are driven by a three-throw crankshaft and a 12½-horsepower motor is employed to operate it. The height between the tension bars is 90 inches and the machine will take wheels 84 inches in diameter on the tread.



Ninety-inch Niles 600-ton Hydraulic Wheel Press.

THE OWEN NO. 2A UNIVERSAL MILLING MACHINE.

In re-designing their No. 2 universal milling machine to make it more suitable for use in taking heavy cuts with high duty steel, the Owen Machine Tool Co., of Springfield, Ohio, have added a number of improvements in mechanical detail. The telescopic shaft in the feed motion has been entirely dispensed with, the connection between the spindle and the feed screw on the table being entirely effected by positive gearing and splined shafts, no chain even being used between the spindle and the feed box. The rapid change gear mechanism used employs spur gears and straight steel clutches entirely, allowing the feed mechanism to be changed at all times when the machine is in motion without injuring it or any of the working parts. Thirty-two changes are obtained; four changes are controlled by the handle shown under the large back gear at the rear of the column; four are obtained in the gear box at the side of the knee controlled by a similar handle, while another lever on the knee gives still another change, making in all 4 x 4 x 2, or 32 changes. The ratio of feeds is arranged in geometrical progression.



Owen No. 2A Universal Milling Machine.

The table has been given double bearing surfaces, the gears, spindles and arbors are made of forged steel, and the front spindle bearing in particular has been given great strength. All of these conditions tend to make the machine more rigid and suitable for the most severe service the tools used are capable of giving it. The knee of the machine has also been redesigned so as to effect a proper distribution of the material, which, with the increased weight given it, makes an exceedingly stiff construction at this point.

CYLINDER RING GRINDER.

The Graham Mfg. Co., Providence, R. I., have designed a grinding machine for finishing piston rings according to the method invented by Mr. Warren Chambers, of Toronto, Ontario. A description of this method was given in the April issue of MACHINERY (page 413 of the Engineering Edition). It will be remembered that with this machine the piston ring is dropped into a container of the same inside diameter as the cylinder in which it is to be used. The ring is shown in place in the container in the line cut Fig. 1, being represented by the heavy black area. The ring is revolved slowly by a projecting pin on the rotating dog in the center. Through an opening in the side of the container the face of the emery wheel is brought to bear on the outer surface of the ring which is here exposed to the action of the wheel. The great advantage of this system is that the ring is finished under exactly the same conditions that obtain when it is in place in the cylinder. With any other known method of finishing the periphery the ring will be found not to follow

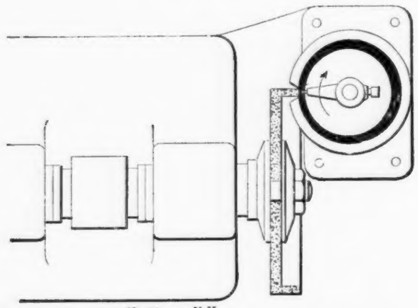


Fig. 1. Diagram of Action of Cylinder Ring Grinder.

exactly the contour of the cylinder, and hand fitting will be necessary if an accurate bearing is desired. For a further discussion of this subject the reader is referred to the article in our April issue.

Figs. 2 and 3 show the arrangement of the machine as designed by the Graham Mfg. Co. On the vertical column of the machine is mounted a head with a spindle carrying a cup emery wheel, whose edge is presented to the work in the manner shown in Fig. 1. From a small pulley at the rear of this spindle a belt is led to a large pulley at the base, which drives, through suitable gearing, the vertical shaft under the work holder. This vertical shaft, which drives the revolving dog, is furnished with universal joints as shown, in order that its upper end may freely follow the movement of the slide which carries the work. This slide may be fed in toward the wheel or brought back from it by means of the handwheel shown. The top of the slide is provided with T-slots for holding the various containers required for piston rings of different diameters. The rotation of the work may be stopped or started by means of the handle at the base of the machine.

Fig. 2. General View of Cylinder Ring Grinder.

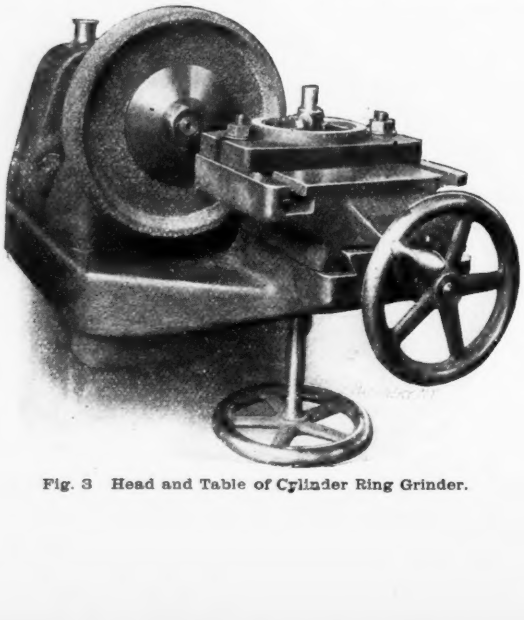
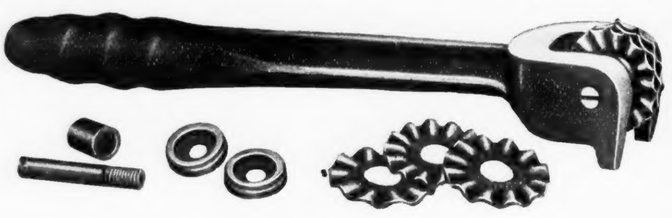


Fig. 3 Head and Table of Cylinder Ring Grinder.

SHERMAN EMERY WHEEL DRESSER.

An emery wheel dresser of new design, made by the Sherman Mfg. Co., Detroit, Mich., is shown herewith. The cutters, owing to the arrangement of the corrugations, always remain sharp until they are worn entirely away. Their life is lengthened by making them of a high grade of tempered tool steel. Each cutter is given a different number of corrugations, thus preventing them from "nesting" together and at the same time giving each cutter a different cutting edge. They are mounted on a bushing which revolves on a spindle, thus giving a better journal than is the case in dressers so designed that the disks revolve directly on the pin. Hardened concave washers are inserted between the cutters and the sides of the handle to prevent wear at this point.

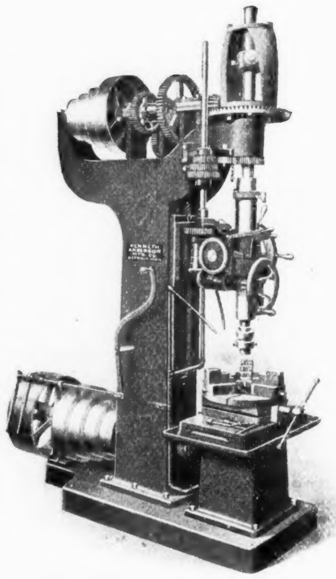


Sherman Emery Wheel Dresser.

THE MURCHEY IMPROVED TAPPING MACHINE

The tapping machine shown in the accompanying halftone is built by the Murchey Machine & Tool Co., 33 to 37 E. Atwater St., Detroit, Mich. The machine consists essentially of a rigid cast-iron column supporting a vertical tapping spindle, with the necessary pulleys and gearing for driving it. It is especially designed for the rapid production of steam and gas pipe fittings, as well as for special work. Simplicity, strength, driving power and convenience of operation have been considered in designing it.

One of the most important of the improvements introduced in this machine is the means provided for transmitting rotary motion from the bevel gear to the tapping spindle. As will be seen from the cut, this is accomplished by a collar clamped to the upper end of the spindle and carrying two arms on which rollers are pivoted. These rollers travel on a surface provided for them on a casting clamped to the upper face of the bevel gear. The rotary motion is thus transmitted from the bevel gear through the casting to the rollers and the arm to which they are pivoted, which is in turn fast to the spindle. It will be noted that the bearing surface of the casting for the rollers is not vertical, but is inclined at an angle. This assures absolute ease of action in feeding a tap into the work, no matter how great a pressure may be needed to rotate it; this result cannot be obtained with the usual sliding key.



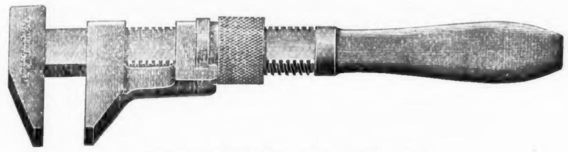
Murchey Improved Tapping Machine.

The table shown has a lateral and transverse adjustment which quickly and accurately centers the tap in a cored hole. This machine is not reversed to back the tap out, being provided with one of the builders' automatic collapsing taps, which have an adjustable stop arranged to come in contact with the sliding head which expands the chasers, and also causes the tap to collapse when it has reached the proper

depth. When desired, this machine will be furnished with a lead screw which may be made to fit any pitch of thread to suit requirements; it can also be fitted with a lever feed, hand feed, or power feed with automatic stop, according to requirements. The back gears and cone pulleys provided give eight spindle feeds. The machine shown has a range for tapping from ½ inch to 4 inches diameter inclusive. The builders are prepared to furnish special chucks for gripping flanges or fittings, and can furnish tapping machines for all sizes up to 12 inches diameter. Any suitable style of table can be furnished.

BEMIS & CALL STEEL NUT WRENCH.

The H. T. Bemis & Call Co., Springfield, Mass., have added to their line of wrenches the new design shown in the accompanying cut. The head bar and shank are made in a one-piece steel forging. The nut gives great gripping power to the jaws since as it has bolts or nuts which have the corners rounded off the whole hand can be applied for tightening the jaws of the wrench. Ordinary adjustments can be made with



Bemis & Call Steel Nut Wrench.

the thumb and finger. A special feature of this tool is the construction of the handle. It is made of steel and is forced onto the wrench under great pressure, then securely riveted in place. Being oval in form, it fits the hand and does not lame it in using as a straight handle will. It is adapted for use where the wooden handle wrench will not answer, as it cannot be injured by water, steam or heat.

* * *

A study of certain toys and mechanical devices put on the market to entertain or puzzle an audience is often of value to the mechanical designer. New applications of old principles are met with which may be profitably used to simplify a mechanism or to effect motions that would be difficult to secure otherwise. Suppose for example that it were desired to rotate a vane inside of a hermetically sealed case. If it were required that no opening be made through the side of the case the rotation of the vane would present seemingly impossible difficulties if the case were made of iron. The use of iron would, of course, prevent the use of magnetism so that about the only substitute for direct mechanical movement would seem eliminated but there still remains the possibility of using certain vibrations which, if properly applied, would rotate a light running vane under the conditions named with no mechanical connection whatever save that of the case itself. To illustrate, a little toy is sold by the street fakers called "Maz-zaz-zas," which is very mystifying in its action. It consists simply of a ½ inch square stick about 8 inches long having a nail driven in the end on which is suspended a light tin strip perfectly balanced and free to rotate. One corner of the stick is notched. The operator holds the stick in one hand while he rubs the notches with a match or toothpick, meanwhile pressing against one side of the stick with his moving thumb. The result is that the tin vane rotates rapidly in one direction. Now, if the pressure of the thumb is removed and pressure is applied by the forefinger on the opposite side of the stick the vane will commence rotating in the opposite direction. The explanation apparently is that the vibrations induced by the rubbing of the match together with the pressure of the thumb on the side of the stick causes the end of the stick to vibrate in a minute circular path which motion is communicated to the vane causing it to rotate. That these peculiar vibrations can be duplicated mechanically there is no doubt, hence the possibility of producing rotary movement of a vane in a hermetically sealed case with no mechanical connection thereto, save that of the case itself.

* * *

The fifth annual convention of the National Machine Tool Builders' Association will be held in New York, Oct. 9 and 10.

INDUSTRIAL NOTES FROM GERMANY.

Fifty Years Anniversary of the Society of German Engineers.—On June 11, 12 and 13, the Society of German Engineers held their 47th general annual meeting at Berlin and combined therewith the fiftieth anniversary of the society. Engineering societies from all parts of the world had sent representatives to express their hearty wishes. The American Society of Civil Engineers was represented for its members by Professor K. E. Hilgard of Zurich, who addressed some hearty words to the assembly. He referred to the International Engineering Congress of 1893 in Chicago as one of the most important meetings between German and American engineers. Both before and ever since this date American engineers have reaped much benefit from German science, German research and German skill. He then welcomed in the name of the American Society of Civil Engineers and all other American engineering societies all German engineers coming to the United States, and expressed the hope that the friendly relations between German and American engineers might always increase to the benefit of humanity. He closed with *a vivat, crescat, floreat* for the Society of German Engineers.

In course of the following days various interesting papers were read, of which we will only mention those of Professor Riedler-Berlin: "On the Development of Steam Turbines and their Importance at the Present Day" (a critical review on the various existing types of steam turbines, *Zeitschrift des Vereines deutscher Ingenieure*, 1906, Nos. 31, 32); Mr. O. Lasche: "The Construction of Steam Turbines by the Allgemeine Elektrizitätsgesellschaft in Berlin" (details on the various types, modes of construction, etc. *Zeitschrift des Vereines deutscher Ingenieure*, 1906, No. 33); Professor A. Rateau, Paris: "On the Rateau Steam Turbine (details on the Rateau steam turbine and the Rateau exhaust steam accumulator, *Zeitschrift des Vereines deutscher Ingenieure*, 1906, Nos. 37, 38).

Experiences and Tests with High-speed Drills in Railway Workshops.—By Government Works Manager Seiler, Berlin. The author expresses his surprise that high-speed tools, which have been extensively introduced in private industries, have not found the same reception in government workshops. His purpose is to show the advantage the use of such tools, and particularly high-speed drills in government railway workshops will afford. The reason why high-speed tools have not been successfully introduced in railways works he ascribes to the fact that the tools are generally made at the works themselves, where in consequence of the forging heat and owing to the lack of suitable tempering furnaces a great deal of hardness of the high-speed steel is again lost.

In order to prove the actual advantages of such high-speed steels he made various tests with high-speed steels from different manufacturers, which, however, with the exception of the Phœnix steel of Bleckmann in Steiermark were neither very successful nor satisfactory. Of this steel drills both pressed and drop-forged were employed, the latter, however, proving to be an entire failure, as they were much too soft. The results of the trials with pressed drills made of Phœnix steel are given in the following table:

Number	1	2	3	4
Revolutions per minute	103	165	200	200
Diameter of drill	3/8	5/8	3/4	3/4
Material drilled	Cast-iron brake-shoes.		Tool steel	
Duration of test, seconds	220	170	485	250
Depth of hole, inches	3 3/8	3 3/8	8	8
Speed of feed	15/16	1 1/4	1	1 15/16
Remarks	Drills not weakened, but belt slipped.		drill began to break out at edge.	

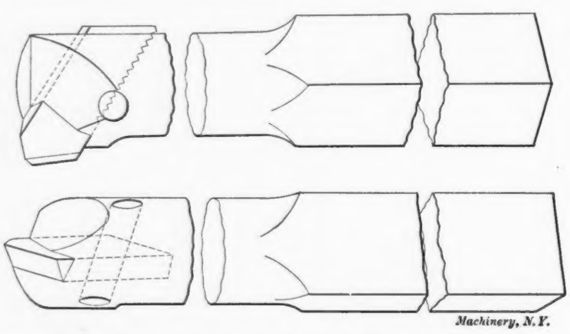
A drill made of ordinary steel, being subjected to the same tests was blunted after only a few revolutions.

The tests with the other steels were not all satisfactory for reason of inferior quality of the steels; occasionally also the machines on which the tests were made were not strong enough, or the power at disposal not great enough to allow of obtaining the full capacity of the tools. This also might frequently be the reason why customers complain of not having been able to obtain full satisfaction with the steel.

At a later series of tests the author was able to obtain a feed of up to 3 inches with a $\frac{7}{8}$-inch drill running at 260 R. P. M. in wrought iron, the test being, however, terminated by the tool splitting up. Such splitting of the drills he ascribes to the feed limit being exceeded and fears steel manufacturers frequently claim too high capacities for their high-speed steels only to beat competition.—*Glaser*, 1906, Vol. 59, No. 2, 4.

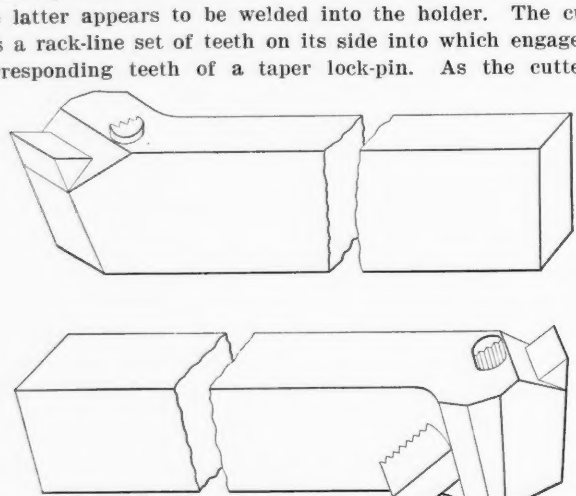
Machine Tool Trade in Germany.—Extraordinary activity exists among German manufacturers of machinery and machine tools. Various great iron works, ship-yards and other establishments are increasing their plants; also, the export trade to Russia is not so bad as might be expected under the present conditions. Great hopes are, however, entertained as to the expected increase of trade, when Russia calms down at last. Germany exported to Russia from March to June, 1906, machine tools to the amount of 8,350 pounds. This figure is very low compared with the figures of 1905-1903, viz.: 92,000, 72,000, 64,000 pounds respectively; or even compared with the export in January and February, 1906, viz.: 30,000 pounds, the figure is low. The reason is the increased duty on machine tools imported into Russia.

Tool-holder.—A new high-speed cutting tool-holder has been patented by Messrs. Mummenhoff & Stegemann of Bochum. The holder is made of very tough forged steel in the form of



Mummenhoff & Stegemann Inserted Cutter Boring Tool.

a cutting tool and encloses the cutter proper so entirely that the latter appears to be welded into the holder. The cutter has a rack-line set of teeth on its side into which engage the corresponding teeth of a taper lock-pin. As the cutter is



Mummenhoff & Stegemann Inserted Cutter Turning Tool.

closely and entirely enclosed by the holder the heat produced by cutting will readily pass over into the holder. On the cutter wearing down it can be advanced tooth by tooth.

International Motor Car Show, Berlin, Autumn, 1906.—A fine new building has been erected in the Hardenbergstrasse along the Berlin Zoological Gardens, intended to serve as hall for periodical exhibitions, etc. It will be inaugurated on November 1, 1906, on occasion of the festival opening of the Autumn Motor Car Show, 1906. This show has been arranged to last from November 1 to November 12, thereby enabling exhibitors to visit the London and Paris shows following. Emperor William II., who like his brother, Prince Henry, has a lively interest in motoring, has promised to be present at the opening. 13,000 m² covered, and 2,000 m² uncovered area is at disposal for exhibition purposes in these new premises.

The well known machine tool works of Ernst Schiess of Düsseldorf, have been converted into a limited company. The principally concerned are the Deutsche Bank and the banking firm, C. G. Trinkhaus of Düsseldorf. The capital of the new firm amounts to 5,500,000 marks, of which 3,500,000 marks will be invested in shares.

Benz & Co. Rheinische Gasmotorenfabrik, Aktiengesellschaft, Mannheim, are intending to extend their works, thereby meeting a long-felt want. No definite decision has as yet been made as to the site of the new premises.

Messrs. Thyssen & Co., of Mühlheim o/Ruhr (Germany), have purchased about five acres of land in addition to the area already covered by their works. They intend to take up the manufacture of locomotives as a specialty.

Concordia Elektrizitäts A-G. Cologne-on-Rhine (Germany): Under this name a new concern has been established with the purpose of erecting electric power stations and plants.

Berlin, September 15, 1906. D.

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OBITUARY.

William H. Owen, formerly president of the Owen Machine Tool Co., Springfield, Ohio, died at his home in that city August 31.

James A. Burden, the well-known ironmaster and inventor of Troy, N. Y., died at his New York home September 23. He was born in 1833 and was the son of Henry Burden, the inventor of the horseshoe machine.

William F. Kennedy, who is said to be the inventor of the base burner radiator stove with shake and dump grate commonly used for heating rooms, died a few months ago in Providence, R. I., at the age of 82.

* * *

PERSONAL.

Erik Oberg, for the past three years draftsman in the small tool department, Pratt & Whitney Co., Hartford, Conn., has joined the editorial force of Machinery.

A. L. De Leeuw is engineering the new plant to be erected by the Cincinnati Milling Machine Co. at Oakley, Ohio, a suburb of Cincinnati.

Mr. and Mrs. Amos Whitney celebrated their golden wedding September 8 at their residence, No. 568 Farmington Ave., Hartford, Conn.

Arthur W. Cole leaves the University of Maine to act as instructor of steam engineering for the coming year at Purdue University, Lafayette, Ind.

Mr. M. Koyemann, the representative for Northern Europe of the Jones & Lamson Machine Co., the Fellows Gear Shaper Co., and other American manufacturers, is in this country and expects to stay until the latter part of October.

T. E. Barker, for ten years with the Miehle Printing Press & Mfg. Co., Chicago, Ill., in various executive positions, has resigned to accept the position of superintendent with the America Co., hardware specialty manufacturers, Momence, Ill.

Edward R. Markham, 66 Dana St., Cambridge, Mass., a well-known contributor to Machinery, is now giving up part of his time to consulting engineering practice, making a specialty of advice on hardening, tempering and annealing steel, and general shop work.

Thomas M. Brown has taken charge of the machinery department of the William Skinner Shipbuilding & Drydock Co., of Baltimore, Md. Mr. Brown had been identified with the machinery trade for many years, but for the past two and a half years was in another line of business. His friends will be pleased to learn of his return to his former work.

Wm. A. Bole, for many years superintendent and works manager of the Westinghouse Machine Co., East Pittsburg, Pa., has been made consulting engineer of that company, and vice-president and general manager of the Westinghouse Consolidated Foundries Co. This concern, located at Trafford City, about five miles from East Pittsburg, will do all the foundry business of both the Westinghouse Machine Co. and the Westinghouse Electric & Mfg. Co.

FIRE EXTINGUISHER FOR MARINE COAL BUNKERS.

One of the most difficult things to combat on board ship is fire in the coal bunkers. Bituminous coal containing iron pyrites is likely to become on fire by "spontaneous" generation of heat sufficient to cause ignition. When fire is discovered in stored coal the common impulse is to fight it by pouring streams of water upon it but this is generally ineffective. A smouldering fire at the bottom of a coal pile forms a mass of coke around it which will not permit the entrance of water in sufficient quantity to drown out the fire, but the heat will change the water to steam and then to water gas which if confined in close places like the hold of a ship is likely to form explosive mixtures. Prof. Vivian B. Lewes suggests that a valuable and effective fire fighting apparatus for coal bunkers would be carbon dioxide stored in strong steel cylinders provided with a fusible plug. Carbon dioxide compressed to liquid state requires a pressure of 1,700 pounds per square inch, and when it expands it produces intense cold, and is also a non-supporter of combustion. In case of fire in the vicinity of one of these cylinders the combustion would be stopped by the reduction of temperature as well as the absence of oxygen. One hundred cubic feet of carbon dioxide can be condensed in a liquid state in a steel cylinder having a capacity of about 7 cubic feet. A ton of average coal contains about 12 cubic feet air space so that one of these cylinders should be put in for every 8 tons of coal in order that the carbon dioxide gas would be sufficient to displace all the air within the coal mass.

* * *

FRESH FROM THE PRESS.

THE Machine Tool Pocket List formerly published by Angus Ballard Co. has been purchased by the Geo. H. Gibson Co., Park Row Building, New York. The size of the publication will be increased from 3½ x 6 inches to 4 x 9 inches. The buyers' finding list of machine tools and supplies will be made still more complete and definite. Brief articles of interest to manufacturers of machinery will also be added and the list will be combined with *Manufacturing*, a journal published by the Geo. H. Gibson Co., which describes and lists important patents and other industrial opportunities.

THE MCCONWAY & TORLEY CO., Pittsburg, Pa., have recently issued a new edition of the "Car Interchangeable Manual," covering all decisions of the Arbitration Committee from November, 1888, up to and including case No. 703 of May, 1906. They are making a general distribution of this book to railway car men, but any who have not received a copy may obtain it free of charge on request. The McConway & Torley Co. have also issued a pamphlet entitled "Ready Reference Tables," designed particularly for car men, and they now have in press a new edition of "Catechism of M. C. B. Rules." Any or all of these books will be sent to railway men free of charge.

CATECHISM ON PRODUCER GAS. By Samuel W. Wyer. 42 pages, 4¼ x 6½ inches. 3 cuts. Published by the McGraw Publishing Co., New York. Price, $1.00 net.

This timely little book is gotten up in the familiar catechism style popular for instilling elementary knowledge on engineering subjects. It contains a considerable amount of information on producer gas, its manufacture, the apparatus employed, etc. The subject is one which is rapidly becoming more and more important. The gas producer plant and the gas engine are quite likely to displace the steam power plant, wherever economy is a prime requisite. As a primer or introduction to the subject, this little work can be recommended.

WIRING A HOUSE. By Herbert Pratt. 21 pages 5¼ x 8 inches. 6 cuts. Published by the Derry-Collard Co., New York. Price, 25 cents.

This little book is No. 6 of a series of practical papers published by the Derry-Collard Co., and is written by one who has had much experience in the planning of wiring and the actual wiring of houses and other buildings. It is chiefly devoted to the wiring of houses already built which, of course, is a much more serious job than the wiring of new houses. The necessary calculations for obtaining the sizes of wire are given and other practical information which should be useful to those contemplating the doing of such work.

HELPFUL HINTS FOR HARDENING STEEL. By Jos. W. Bennett. 83 pages 3½x5 inches, 12 cuts. Published by the author at New Britain, Conn. Price $1.00.

The author has had thirty-five years' experience in hardening and tempering tool steel and should, therefore, be in a position to give some good practical hints to other workers of tool steel. A number of the hints given could easily be worth many times the cost of the book to some steel workers. Following are a few of them: How to anneal steel containing hard and soft spots; how to harden blanking dies; how to harden a drill jig or reamer bushing to prevent shrinking; how to harden spring collets; how to prevent taps from shortening in the lead, etc. The author includes a coupon in each book which entitles the purchaser to the privilege of asking questions from time to time concerning hardening and tempering steel, a feature that doubtless will be appreciated by some purchasers.

THE AMERICAN STEEL WORKER, by E. R. Markham. 366 pages, 5½ x 7¾. 163 cuts. Published by the Derry-Collard Co., New York. Price, $2.50.

This is the second edition of Mr. Markham's excellent work on the working, hardening and tempering of the various kinds and grades of steel. It is doubtless the best practical work on the subject for the smith, toolmaker and general mechanic. The second edition has been improved in a number of ways. It is printed on thinner paper, making the volume more compact, and an appendix of 24 pages has been added on high-speed steel. An excellent feature of this work which cannot be too highly commended is a copious index of contents, this part covering 28 pages. The value of a complete index to a work of this kind can scarcely be over-estimated for its chief value lies as much, perhaps, in being a work of reference, as for the general information to be obtained by one reading, and the index is an important time-saver.

DESIGNS OF SMALL DYNAMOS AND MOTORS. By Cecil P. Poole. 186 pages 6 x 9 inches. 231 cuts. Published by the McGraw Publishing Co., New York. Price, $2.00 net.

This book is designed for the amateurs and others who desire to build small electrical motors. Most of its chapters were originally articles published in the *American Electrician*. The book gives directions, with sketches, for building a 1-6 horse-power motor with drum armature and with ring armature and the same designs for ¼ and ½ horse-power; also for 1 horse-power bi-polar motor and four-polar motor with drum armature; 2 horse-power four-polar motor with two-path drum armature; direct current 110 volt motor; three horse-power launch motor, etc. The designs and sketches have, we believe, been verified by actual construction, so that they are, for the most part, reliable guides for the amateur builder. Perhaps one of the best ways of getting the elements of electrical science well grounded is to construct some simple electrical apparatus like examples shown in this work and to such this book should appeal.

BRAZING AND SOLDERING. By James F. Hobart. 33 pages, 5½ x 8 inches. 16 cuts. Published by the Derry-Collard Co., New York. Bound in paper. Price, 25 cents.

This little book is No. 5 of a series of practical papers, and it should meet with general approval, being on a subject on which there is more or less general demand for "pointers." It treats of soldering, hard and soft, that is, brazing with spelter and soldering with the tin and lead solders. The author has had much practical experience in this class of work and he has illustrated the text with sketches which show plainly the various tool and methods employed. Hard soldering, or brazing, is one of the most useful methods of making sound joints, and next to welding, is the strongest. But, unlike welding, it is applicable to a considerable class of metals either similar or dissimilar; as, for example, brass to brass, or brass to iron, and so on. In the chapter on soldering various forms of soldering bits are illustrated and the correct method for taking solder from a bar. We have no doubt that amateur users of a soldering kit can learn a number of useful hints by reading this little work.

COMPLETE EXAMINATION QUESTIONS AND ANSWERS FOR MARINE AND STATIONARY ENGINEERS, by Calvin F. Swingle. 367 pages, 4¼ x 6¾ inches, 212 cuts. Published by Frederick J. Drake & Co., Chicago, Ill.

As indicated by the title this book is of the familiar and popular catechism type in which questions are proposed and answered in a succeeding paragraph. This form of technical literature appeals to the firemen, engineers, and those who are required to pass an examination in order to obtain a license. It formulates the question and a presumably accurate answer thereto in a way which is concise and to the point. The book in review appears to be a fair example of this class. It covers a considerable range and must necessarily be more or less superficial when the available space is considered. It touches on steam, heat, combustion, fuel, boilers, boiler construction, boiler settings and appurtenances, boiler operation, types of engines, condensers, pumps, sea-water, auxiliary machinery and fittings, the indicator, principles of the indicator, the steam turbine, etc. The cuts are a collection of wood cuts, zinc etchings, and halftones, and are in many cases of a totally disproportionate size to the page and subject. The book, on the whole, is one that will doubtless be of considerable benefit to the class for which it is designed.

HANDBOOK OF MATHEMATICS. By J. Claudel. Translated and edited by Otis A. Kenyon. 708 pages 6 x 9 inches, 422 figures. Published by the McGraw Publishing Co., N. Y. Price, $3.50 net.

The original of this book is a French work intended for engineers and engineering students and the translation is from the seventh French edition. It is intended primarily as a reference book, but it is also well adapted for home study. The translator says in the preface: "The use of text books for reference by the busy man is discouraging. For example, if he wishes to solve an integral which is not given in the table he naturally refers to his text book on integral calculus, spending several hours studying, and then finds that his trouble is farther back, most likely in algebra. The chances are that due to lack of time he will give up and declare that he has forgotten his calculus." In the preparation of this work the trouble mentioned has been anticipated by the very frequent use of cross references, completely interconnecting all parts of the book. The book is divided into six parts, as follows: Arithmetic, Algebra, Geometry, Trigonometry, Analytic Geometry, and Elements of Calculus. From a somewhat superficial examination of the work it appears to be one that almost any engineer would be glad to have on his book shelves to occasionally refresh his knowledge of mathematics. It is well gotten up, the type being large and clear, formulas distinctive, and the tables well arranged.

TECHNICAL DICTIONARY, Vol. 1. By K. Deinhardt and A. Schlomann. 403 pages. 4 x 7 inches; illustrated. Published by the McGraw Publishing Co., New York. Price, $2.00 net.

The scheme of this dictionary, which is to be published in eleven volumes and in six languages, is to present (if possible) a sketch of the thing named in the middle of the page and to give its name in English, German, French, Russian, Italian and Spanish, in parallel columns one at each side. The dictionary presents three distinct features: 1, index; 2, systematic arrangement of matter; 3, alphabetical index of words. For example, in the division Screws and Screw Bolts, the first sketch shows a helical line around a cylinder. This is defined in the six languages, then follow "angle of inclination, "pitch," "helicoidal surface," "thread of screw," "the screw has x threads per inch," "screw-thread," etc. It is, of course, obvious that certain ideas cannot be represented by sketches, so that each definition does not necessarily have a sketch to accompany it. The general arrangement of the work makes its use very convenient. Vol. 1 is on the elements of machinery and the tools most frequently used in metal and wood-working. Among the machine elements are listed Screws and Bolts; Keys, Rivets, Axles and Shafts, Trunnions, Bearings, Lubricators, Couplings, Gearing, Friction Wheels, Belting, Chain Transmission, Rollers, Ratchet-gearing, etc. Under the general head of tools we have Vises, Tongs, Anvils, Hammers, Chisels, Files, Scrapers, Drills, Milling Cutters, etc. The scheme of illustrating each machine part, etc., by means of sketches, which is a universal language understood by all, makes the work one of great general value and one to be commended to the needs of those having to make technical translations.

THE DESIGN AND CONSTRUCTION OF CAMS. By Chas. F. Smith, Frederick A. Halsey and others. 70 pages, 9 x 12 inches. 62 cuts. Published by the Hill Publishing Co., New York. Price, $3.00.

This book is largely a reprint of the articles on cams that have appeared in the *American Machinist* during the last year or two, and which undoubtedly constitute one of the best treatments of the subject to date. Mr. Smith, the principal author, has been connected with the construction of machinery involving the use of cams for twenty-five years, and naturally he has made the study of cams a specialty. When it is known that he has designed machines containing as many as twenty cams, all of which were laid out and keyseated from drawings and assembled without change, working in entire harmony, it must be admitted that his system is one that gives correct results. The book by chapters is as follows: Classification of Cams in Order or Work; the Machine from which the Illustrations are Drawn (being a wire chain-making machine); the Operation of the Chain-Making Machine; Charting the Movements; Laying out an Actual Face Cam, Making the Former and Milling the Cam; Laying Out and Making Periphery Cams; Raised Pathway, Yoke and Conical Cams; Cams for Prescribed Movements; Repeated and Return Movement Cams; Charts with a Separate Base Line for Each Cam, Abbreviated Charts, Extreme Angles, Locating Keyways; the Double-Cam System of the Monotype; Cam Movements Obtained from Base Curves Other Than the Circle; the Location of Lever Fulcrums for

Face Cams; Minute Adjustment of Cam Lever Movements; Grinding Cams. The size of the page (9 x 12 inches) permits the use of large drawings, but even with this size page it has been necessary to introduce one folding chart, being the cam chart of the chain-making machine. Altogether, we can recommend the book as being a first-class work on a technical subject in general little understood.

NEW TRADE LITERATURE.

FITCHBURG MACHINE WORKS, Fitchburg, Mass. Supplementary booklet on the Lo-swing Lathe, giving some details about the machine and instructions for its operation.

ATLAS ENGINE WORKS, Indianapolis, Ind. Bulletin No. 132 describing medium speed automatic four-valve engines and their various parts and giving tables of specifications for the different classes.

CROCKER-WHEELER Co., Ampere, N. J. Bulletins 66 and 67, taking for their subjects Form I-F Variable Speed Motors and W Motors for Rolling Mills, respectively. The usual description, illustrations and tables of specifications are included.

MODERN TOOL Co., Erie, Pa. Catalogue describing and illustrating their various tools—chucks, tapping attachments, dies, grinders, etc. Tables of U. S. Standard bolts and nuts, drills for U. S. S., V., and Whitworth thread and decimal equivalents of nominal sizes of drills are also included.

THE BICKFORD DRILL & TOOL Co., Cincinnati, Ohio. Radial Drill catalogue for 1906. Halftone illustrations show the complete line of radial drills and descriptions of the various parts and general specifications for the different styles complete the data.

NEWTON MACHINE TOOL WORKS, Inc., Philadelphia, Pa. Catalogue No. 44—Keyseat Milling Machines, illustrates and describes the two sizes of this machine, and enlarged illustrations make clear the method of operation. A special machine for locomotive axles is shown and a new design of machine used for heavier and longer shafts is also illustrated.

QUINCY, MANCHESTER SARGENT Co., 114 Liberty Street, New York City, have issued a new catalogue with adjustable leather cover fastened by screws, by means of which new leaves may be inserted as they are issued. The book contains illustrations and brief descriptions of the standard tools of the company, attention being called to the more important points only.

THE P. L. ABBEY Co., Kalamazoo, Mich. Circular describing emergency accident cabinets for individuals, shops or stores and manufacturing plants. The $7.00 size, designed for the manufacturing plant, comprises an emergency outfit, for accidents, that no shop should be without, as its presence may often save loss of life or serious consequences due to an accident not being properly attended to in time.

NATIONAL ASSOCIATION OF MANUFACTURERS, 170 Broadway. Proceedings of the 11th annual convention, 1906, held at New York, May 14-16. The proceedings are given in full, including addresses of welcome, committee reports, etc. The proceedings are well worth study by those interested in discussions of the labor problem, strikes, metric system, railroad rate legislation and general commercial problems affecting manufacturers and their products.

ASSOCIATION OF LICENSED AUTOMOBILE MANUFACTURERS, New York. Bulletin No. 18, containing standard for hexagon head screws, castle and plain nuts adopted by the Association of Licensed Automobile Manufacturers. It has been found that the Sellers, or U. S. Standard screws, do not meet the requirements of automobile construction satisfactorily, the pitches being too coarse. Tables showing the dimensions, pitches, etc., will be given in a later issue.

J. H. WAGENHORST & Co., Youngstown, Ohio. Leaflet giving in concise form a description of the electric blueprinting machine manufactured by them; also testimonials from satisfied customers. The leaflet includes prices for various sizes of the machine. An important feature is the roller curtain which makes the placing of a tracing and sensitized paper an easily-accomplished operation. It also permits the printing to be examined at any time without the danger of disarranging the relative position of the tracing and paper.

THE GISHOLT MACHINE Co., Madison, Wis. Leaflet descriptive of the Gisholt turret lathe equipment for railroad shops showing tools designed for finishing crossheads, eccentrics, pistons and bull-rings. This equipment is of particular interest because it was thought, not long ago, that turret lathes could not be used economically on such parts on account of the comparatively small number made at one time. This equipment, however, is of such simplicity of construction that it is quickly set up and used economically on a few pieces as well as on a large number.

THE BOARD OF TRADE, of Columbus, Ohio, has issued an attractively illustrated pamphlet on Columbus, showing the principal buildings, streets, manufacturing industries, etc. It tells of the advantages of Columbus for manufacturing industries and as a place of residence. Situated in central Ohio, a radius of 500 miles reaches all the principal parts of Eastern United States, thus indicating that the city is located in a strategic position as regards the distribution of products throughout this part of the country. A map graphically illustrates this fact.

JOSEPH DIXON CRUCIBLE Co., Jersey City, N. J. General catalogue giving description and illustrations of the principal graphite productions of the company. Prices are not included but are given in the form of a special price list, which will be sent free upon request. "Graphite Lubricants" is a booklet setting forth the important facts together with the prices of Dixon's lubricating graphites and graphite lubricants. A little pamphlet on Dixon's Graphite Brushes describes the use of same and gives the results of tests made upon these brushes by Prof. Albert F. Ganz of Stevens Institute.

DREXEL INSTITUTE, Philadelphia, Pa. Circular offering the following classes in engineering subjects during the coming season: 1. Engineering Drawing; 2. Mechanics and Heat; 3. Elements of Chemistry; 4. Engineering Electricity; 5. Advanced Engineering Electricity; 6. Strength of Materials and Machine Design; 7. Advanced Strength of Materials and Machine Design; 8. Thermodynamics and Steam Engineering; 9. Plane Surveying; 10. Advanced Surveying. Although stated separately, the foregoing subjects may be grouped in courses in electrical, mechanical or civil engineering, the exact combinations being dependent upon individual needs.

GEO. V. CRESSON Co., Philadelphia, Pa. Catalogue of cast iron pulleys. The three standard types of pulleys—whole, parting, and clamp-hub—and special pulleys made for use on electrical machines are described and illustrated. In the back of the catalogue is given a report of the tests made by R. C. Carpenter, of Cornell University, to determine the efficiency of the para-pneumatic pulley as compared with the smooth-faced pulley. The results show a decided superiority of the para-pneumatic pulley over the common, plain pulley in transmitting power for the same width of belt and under the same conditions of loading. The tables accompanying the tests give full details of data and results.

CHAS. H. BESLEY & Co., Chicago, Ill. Catalogue of Besley spiral disk grinders, Besley band grinders and polishing machines, Helmet spiral circles, etc. Attention is called to four new machines, these being No. 11, for patternmaking and light metal grinding; No. 12, for heavy metal grinding; No. 14, with lever feed; and No. 6, model 1906, double disk grinder. A feature of the catalogue is the tables of Helmet spiral paper circles numbered for various materials, such as cast iron, brass, soft steel, hard steel, malleable iron, general grinding, hard rubber, wood, etc. About 12 numbers of abrasive are available for each of the various classes of substances. The numbers mostly used are identified by bold-faced type. Books containing sample sections of the various grades of abrasive disks used are supplied to dealers for the convenience of customers in selection.

THE WESTERN TUBE Co., Kewanee, Ill. Pamphlet describing "high duty" metal, a new bronze mixture which shows a loss of tensile strength when subjected to a temperature of 407 degrees F. of only 5.6 per cent. This metal has been developed after an extensive series of tests of known bronze mixtures. The best of these, the United States Government mixture, consisting of 88 parts copper, 10 tin, and 2 of zinc, was found to be as little affected by high temperature as any developed heretofore. The decrease in strength at 407 degrees F. was a drop of 9 per cent from the cold tensile strength of 33,633 pounds per square inch. "High duty" metal, however, shows a strength of 31,627 pounds per square inch at 407 degrees F. as against 30,675 pounds for United States Government metal. Its wearing qualities are good and the alloy is tough, thus resisting shock due to water-hammer, etc.

MANUFACTURERS' NOTES.

EBERHARDT BROS. MACHINE Co., Newark, N. J., are building an addition to their assembling room which will enable them to handle about double the present output.

BURKE MACHINERY Co., of Cleveland, Ohio, manufacturers of oil furnaces and bench machinery, have recently moved to their new factory, corner Perkins Avenue and 35th Street.

THE MORSE CHAIN Co., formerly of Trumansburg, N. Y., have moved their general offices and shops to Ithaca, N. Y., where a new plant of the best modern construction has been erected.

THE ARMSTRONG BROS. TOOL Co., Chicago, Ill., have installed additional machinery so as to keep up with their orders and get some finished stock ahead. The sales of Armstrong cutting-off and grinding machines are increasing steadily.

CHAS. H. BESLEY & Co., 15 South Clinton Street, Chicago, Ill., will exhibit their Besley Spiral Grooved Steel Disc Grinder and their Helmet Spiral Paper and Cloth Circles at the Olympia, London, England, Exposition to be held from September 15 to October 17, 1906.

THE CLEVELAND TWIST DRILL Co., Cleveland, Ohio, have recently completed an addition to their factory that will enable them to increase their capacity 25 per cent. They have also built a new power plant containing a 1,250 H. P. engine and 1,600 H. P. in new boilers.

THE JACOBS MFG. Co., of Hartford, Conn., makers of the Jacob improved drill chucks, have been forced to move into a larger and more convenient factory. They are installing additional machinery and hope in the near future to be able to take care of their rapidly-increasing business.

J. H. WAGENHORST & Co., Youngstown, Ohio, report the following recent sales of electric blue printers: Eugene Dietzgen Co., New York; Wisconsin Telephone Co., Milwaukee, Wis.; Calumet & Hecla Mining Co.; Carnegie Steel Co.; Swift & Co., Chicago, Ill.; the A. O. Smith Co., Milwaukee, Wis.

THE LYON METALLIC MFG. Co., formerly of Chicago, Ill., are now located at Aurora, Ill., where they have erected a large factory, giving them a capacity of over four times the old plant. They will manufacture on a large scale lockers, steel tool boxes, tote pans, oil cans, steel shelving, portable tool racks and all kinds of metal machine shop furnishings.

ARMSTRONG BROS. TOOL Co., "The Tool Holder People" of Chicago, have just shipped two orders received recently from the Isthmian Canal Commission, aggregating almost one thousand Armstrong tool-holders, many heavy sizes being included. They have also received recently an order for universal ratchets for use in the Canal Zone. Many smaller shipments have preceded these later orders.

THE NEW ERA MFG. Co., Kalamazoo, Mich., manufacturers of metallic phosphoro (phosphor tin improved), white bronze, babbitt metals and special alloys, are now occupying their new quarters at the corner of Cobb Avenue and the S. H. Branch of the Michigan Central Railroad, and are thoroughly equipped and prepared to take care of any quantity of business in their line.

JOHN MACGREGOR formerly superintendent of the Pope Manufacturing Co., Hartford, Conn., is now manager of MacGregor's Engineering and Employment Agency, Springfield, Mass. This is a newly organized concern developed on the basis of an old agency which was bought out. It is the intention to conduct a first-class agency for employment by men who have been "through the mill" and know something of the actual requirements of employers and who are personally able to judge of the abilities of employees.

THE GOLDSCHMIDT THERMIT Co., 43-49 Exchange Place, New York, are about to vacate their present manufacturing premises at 179 Christopher St., New York, as they are insufficient for their largely increasing business. They have bought ground at the corner of Cornelison and Bishop Sts., Jersey City, N. J., and have there erected a large factory building 75 x 165 feet. This location is within easy reach of their down-town offices. They intend removing the manufacturing plant from its present location to the new plant on or about October 1st.

THE CARBORUNDUM Co., Niagara Falls, N. Y., have started building a large branch plant in Germany. They are the sole American manufacturers of carborundum in the various forms used for grinding purposes and the demands of their European trade make the establishment of branch works of carborundum on the continent an absolute necessity. The German company has been formed under the title of "Deutsche Carborundum Werke, G. m. b. h.," and is located at Reisholz, a manufacturing suburb of Dusseldorf-on-the-Rhine. The new works, which will embody all the latest and improved machinery for the manufacture of abrasive materials, is expected to be in operation about January 1, 1907.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton, Pa., will celebrate the fifteenth anniversary of the schools at Scranton, Pa., October 16. The schools were started by Mr. Thomas J. Foster, then editor of a newspaper in Shenandoah, Pa. He introduced a method of teaching through the mails by means of special home study text books and a system of direction and correction of student's work, the object of which was to enable the coal miners of Pennsylvania to pass the required examination for mine foremen. It was little dreamed that this was the beginning of a new educational system which would eventually turn the whole world into a vast school room and offer the means by which men in almost every trade or occupation could improve their education and consequently their money-earning power. The school now has 200 courses of instruction, covering almost every branch of the well-known trades and professions. Up to the present time 85,000 students have either completed the course for which they enrolled or a substantial portion thereof; 225,000 other students have completed the study of mathematical, physical and drawing subjects. These figures seem the more impressive when it is known that the largest number of students graduated by any one American school is 28,000, this being the record of Harvard University, an institution more than 200 years old.

CONTENTS FOR OCTOBER.

Brown & Sharpe Mfg. Co., Providence, R. I. Catalogue giving description and specifications of their No. 3-A universal milling machine. The machine embodies the following features: Constant speed drive, making exceptionally well adapted to motor driving; spindle speeds obtained by gearing; feeds independent of spindle speeds; extended knee slide, furnishing stiff support for front spindle bearing; clutched hand wheels, clutches allowing wheels to remain stationary after adjustments are made and preventing accidental disturbances of settings. The company have also issued pamphlets dealing with No. 5 plain milling machine, No. 2 automatic screw machine, No. 13 universal and tool grinding machine, No. 3 automatic gear cutting machine, and No. 3 universal grinding machine.

Pilling & Crane, Philadelphia, Pa. Chart showing statistics of the production of pig iron in the United States—1830 to 1905. In 1830 the production of pig iron was 165,000 tons (2,240 pounds); in 1905 it was 22,992,380 tons. The per capita production has increased from 28 tons to 619 tons in that period.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.